NOTES ON AND ADDITIONS TO THE TROMBICULINAE AND LEEUWENHOEKIINAE (ACARINA) OF AUSTRALIA AND NEW GUINEA

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Since the publication of the preliminary monograph on the "Trombiculinae of the Austro-Malayan and Oriental Regions" by Womersley and Heaslip (Trans. Roy. Soc. S. Aust., **67**, (1), 68-142, 1943) a large number of larvae and a few adults have been received from various localities in Australia and New Guinea. Some of these specimens represent new species, which are described and figured in this contribution.

In the above cited paper, on p. 71, it was also suggested that, when sufficient material was available for study, it would be useful taxonomically, to study the "Standard Data" statistically. The additional material now in hand has enabled me to do this for certain species, and in most cases it is possible to get some idea of the theoretical possible range of variation in the different characters used. In 1943, stress was laid firstly on the number and arrangement of the dorsal setae, and secondly on the Standard Data. The statistical studies show that where the arrangement and number of dorsal setae are close in two species, there are usually significant differences in the statistics of the Standard Data. Further, in certain species it is revealed that there are slight but statistically significant differences in a few or many characters of the same species from different localities. This is of much importance and, as indicating geographical races or variations, may throw some light on the occurrence or not of "scrub-typhus" in different areas.

The statistical calculations have been based on Simpson and Roe's "Quantitative Zoology" and the statistics employed are: (1) Mean, (2) Standard Deviation, (3) Theoretical Range as expressed by $M \pm 3\sigma$, and (4) the Coefficient of Variation.

Closely allied species and different populations of the same species have been compared by calculating the Standard Deviation (Error) of the Difference of Means, using the formula

$$\sigma_d = \sqrt{\frac{N_1}{N_2}\sigma^2_{M_1} + \frac{N_2}{N_1}\sigma^2_{M_2}}$$

and regarding a value of $d/\sigma_d > 2$ as a positive and significant difference.[1]

In the above cited 1943 paper, all the specimens of *Leeuwenhoekia* then available were referred to the one species, *L. australiensis* Hirst. With fresh and additional material now before me, I have found that three species are represented, while three other species are also described. The genus is thus represented in Australia and New Guinea by six species, five of which are new. While studying this material, especially fresh mounts, it was found that the genus differs from all other genera of the Trombiculinae in possessing a pair of true stigmata from which tracheal tubes traverse the body. These stigmata are situated one on each side, between the base of the gnathosoma and the first coxae. The atrium itself is not so well chitinised as the so-called "ventral stigma" or "urstigma" which is present in all larval Trombidiidae between the first and second coxae, and from which no tracheal tubes run. No trace of a true stigma has been seen in any other genus.

[1] d = Difference of Means.

The presence of such an important feature in the genus *Leeuwenhoekia* necessitates the separation of the genus from the rest of the Trombiculinae (except possibly *Hannemannia*) as a new subfamily, the Leeuwenhoekiinae. The genus *Hannemannia* in the structure of the dorsal scutum, with its paired AM, but lacking the median anterior process, is possibly closely related and, if shown to possess true stigmata, should be placed in the new subfamily. No such stigmata have, however, been figured for any species, and the genus is so far unknown from Australia or New Guinea.

In addition two insufficiently described species, *Schöngastia salmi* Oudms. 1922 from Java and *Schöngastiella disparunguis* Oudms. 1929 also from Java, are discussed.

Subfam. TROMBICULINAE s. str.

Genus TROMBICULA Berl. 1905

Acari nuovi; Manipl. IV, 155, in Redia II, fasc. 2, 1905.

Trombicula translucens n. sp.

Fig. 1, A–E

Description—Adult ♀. Colour in life a translucent white with the body contents showing through as a dark mass. Length 850 μ, width across propodosoma 425 μ, across hysterosoma 510 μ. Eyes absent. Crista 104 μ long, with triangular posterior sensillary area, with paired fine ciliated sensillae 50 μ apart at bases and

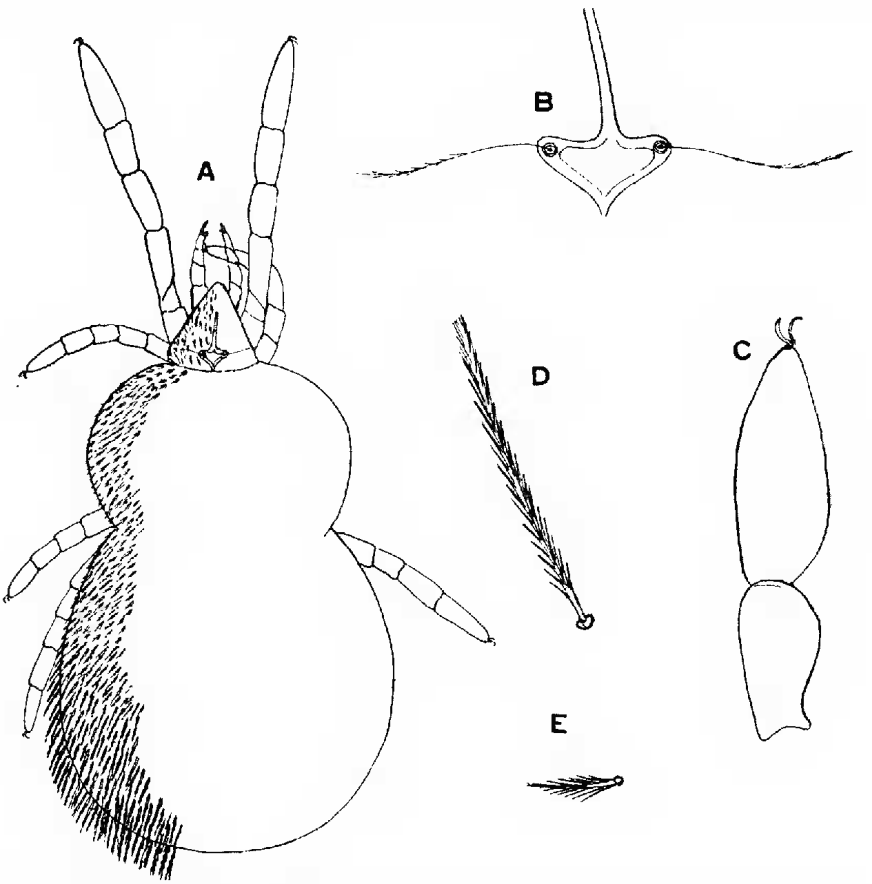


Fig. 1 *Trombicula translucens* n. sp. Adult: A, dorsal; B, crista, C, front tarsus and metatarsus; D, posterior dorsal seta, E, anterior dorsal seta.

75 μ long. Body clothed with strongly ciliated setae, those on the propodosoma short, 13 μ; on hysterosoma anteriorly 13 μ, posteriorly to 65 μ long, and appearing as a characteristic fringe. Legs rather short, anterior the longest; front tarsi 110 μ long by 45 μ wide, metatarsi 65 μ long.

Locality—Two adult females from moss from Mount Arden, South Australia, October 1943 (H. M. Cooper).

Remarks—This species, by the key (*loc. cit.* 1943, 48) to the adults and nymphs, will fall into the *akamushi* group. All of this group, however, are from Japan and are all said to be reddish in colour. The posterior fringe of long setae seems to be rather characteristic.

Trombicula scincoides n. sp.

Fig. 2, A–C

Description—Larvae. Colour in life a light reddish-yellow. Shape oval. Length to 550 μ, width to 340 μ (moderately engorged). Dorsal scutum with

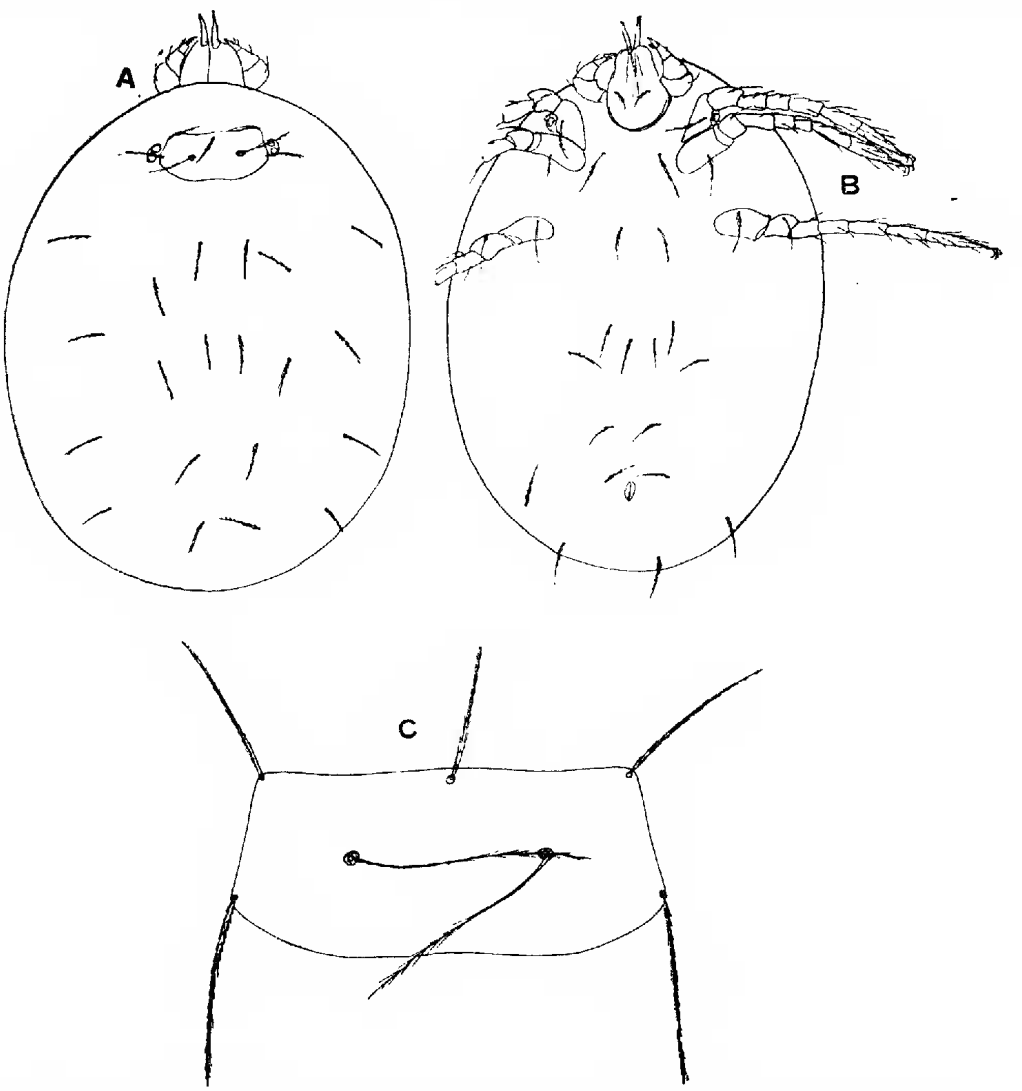
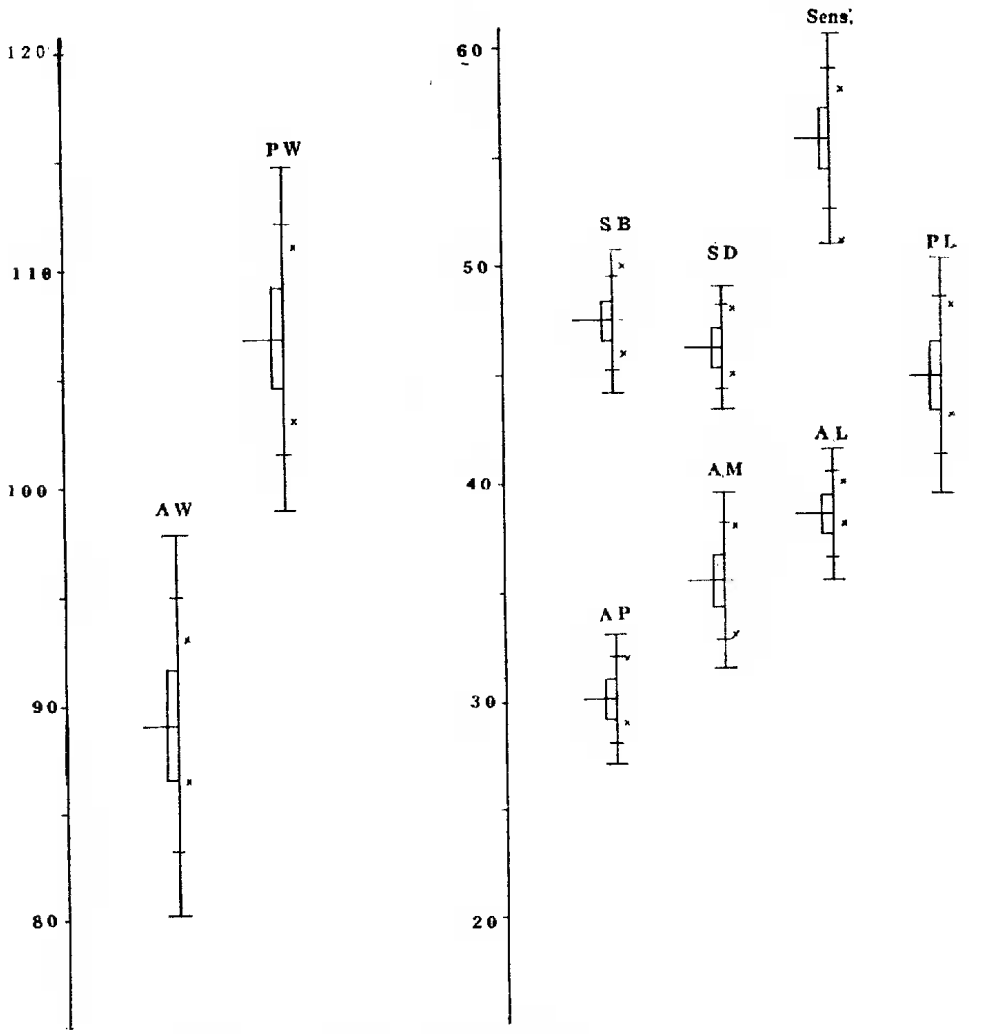


Fig. 2 *Trombicula scincoides* n. sp. Larva: A, dorsal; B, ventral; C, scutum x 500.

transverse rows of punctuations, shaped as in figure and with the following Standard Data in microns, derived from 12 specimens.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	89·1 ± 0·85	2·95 ± 0·60	80·3–97·9	86·5–93·0	3·3
PW	106·8 − 0·76	2·65 ± 0·54	98·9–114·7	103·0–111·0	2·5
SB	47·5 ± 0·30	1·10 ± 0·22	44·2–50·8	46·0–50·0	2·3
SD	46·2 ± 0·30	0·94 ± 0·20	43·4–49·0	45·0–48·0	2·0
A–P	30·1 ± 0·30	0·99 ± 0·21	27·1–33·1	29·0–32·0	3·3
AM	35·5 ± 0·42	1·35 ± 0·32	31·5–39·5	33·0–38·0	3·8
AL	38·5 ± 0·30	0·99 ± 0·21	35·5–41·5	37·0–40·0	2·5
PL	44·8 ± 0·52	1·80 ± 0·37	39·4–50·2	43·0–48·0	4·0
Sens.	55·7 ± 0·48	1·60 ± 0·34	50·9–60·5	51·0–58·0	2·9



Graphs showing the Statistics of the Standard Data of larval *Trombicula scincoides* n. sp. (Measurements in microns.)

PSB is slightly longer than ASB. Eyes 2 + 2, about one diameter from edge of scutum. Mandibles and palpi normal. Dorsal setae arranged 2.6.6.4.2, fairly stout and straight with serrations rather than ciliations. Legs: I 240 μ,

II 260 μ, III 200 μ; all tarsi with paired claws and longer median claw-like empodium, I and II with the usual dorsal rod-like seta. All coxae unisetose with a long slender finely ciliated seta; a pair of such setae between coxae I and between coxae III; thereafter ventral setae arranged 6.2.4.2., the posterior two rows stronger and more like the dorsal setae.

Locality and *Host*—A number of specimens from the axillae of a scink, *Lygosoma* (*Liolepisma*) *bicarinatus* (MacL. 1877) from New Guinea, October 1 1943 (R. N. McCulloch), host *id.* by Mr. J. R. Kinghorn, Australian Museum, Sydney. A single specimen, collected on boots, Buna, N.G., 27 August 1943 (R. N. McC.).

Remarks—In the arrangement of the DS this species belongs to the *minor* group, but comes nearest to *wichmanni* Oudms. in the shape of the dorsal scutum, which is shorter and wider in the new species. The ratio of PW/SD = 2·31 in *scincoides* and 1·85 in *wichmanni*. The DS are not so tapering, nor so finely ciliated as in *minor* and its allies.

Trombicula obscura n. sp.

Fig. 3, A–C

Description—Larvae. Shape oval. Length to 300 μ, width to 150 μ. Dorsal scutum as figured and with the following Standard Data for the two specimens

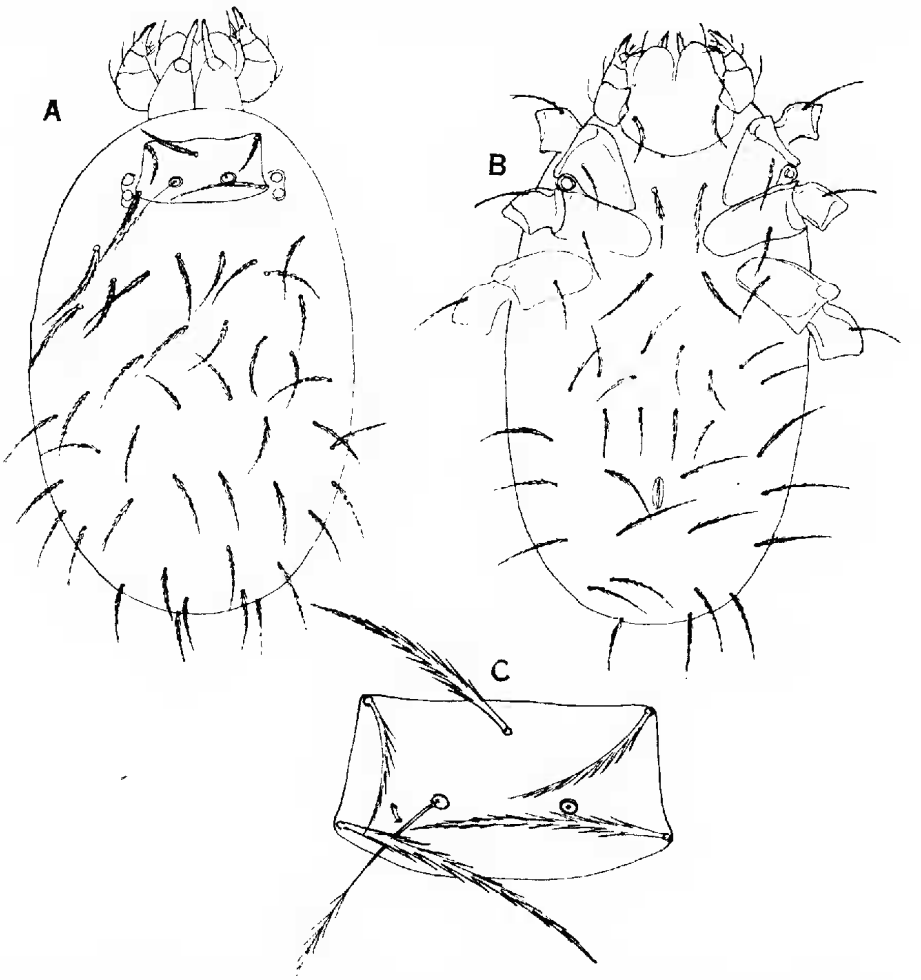


Fig. 3 *Trombicula obscura* n. sp. Larva: A, dorsal, B, ventral; C, sctum x 500.

measured: AW 65, 68, PW 79, 79, SB 32, 32, ASB 29, 26, PSB 14, 18, A-P 32, 32, AM 57, 58, AL 43, 45, PL 70, 72, Sens. 60. 60. Dorsal setae robust and strongly ciliated, arranged 2.8.8.8.6.4.2. Eyes 2 + 2. Mandibles and palpi normal. Legs: I 255 μ, II 205 μ, III 250 μ; tarsi I and II with the usual rod-like seta. All coxae unisetose; a pair of setae between coxae I and between coxae III, thereafter the ventral setae are arranged approximately 4.4.6.4.4.4.2, those posterior of the anal opening being stronger and similar to dorsal setae.

Locality and *Hosts*—Type and three paratypes (only two measured) from the ear of a rat at Milne Bay, New Guinea, August 1943 (A. L. A.), along with numerous *T. deliensis* Walch, and rather fewer *Schöngastia blestowei* Gunther and *Neoschöngastia impar* Gunther.

Remarks—Somewhat near to *T. deliensis* Walch but differing in the number and arrangement of the dorsal setae.

Since drawing up the above description a number of other specimens from Buna, New Guinea, collected from rats, January 1944 (Maj. Hicks) have come to hand. Of these, 10 specimens have been measured, giving the following Standard Data:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	68·3 ± 0·88	2·10 ± 0·47	62·0–74·6	65·0–72·0	3·0
PW	78·8 ± 0·83	1·99 ± 0·44	72·8–84·8	76·0–82·0	2·5
SB	32·6 ± 0·49	1·56 ± 0·35	27·9–37·3	30·0–36·0	4·8
SD	41·1 ± 0·85	2·70 ± 0·60	33·0–49·2	38·0–46·0	6·6
A–P	27·4 ± 0·61	1·96 ± 0·61	21·5–33·3	25·0–29·0	7·1
AM	52·2 ± 0·82	2·33 ± 0·58	45·2–59·2	50·0–56·0	4·5
AL	36·9 ± 0·55	1·66 ± 0·39	31·9–41·9	36·0–44·0	4·5
PL	56·9 ± 1·04	3·30 ± 0·74	47·0–66·8	54·0–65·0	4·8
Sens.	62·6 ± 0·89	2·82 ± 0·63	54·1–71·1	57·0–68·0	4·5

From the above it is seen that the specimens from the two localities agree except in the AL and PL values which are significantly different, but this is not sufficient to regard them as more than different populations of the one species.

Trombicula kohlsi n. sp.

Fig. 4, A–E

Description—Larvae. Shape subrotund. Length (excluding gnathosoma) 216 μ, width in line of coxae III, 180 μ. Dorsal scutum very large and wide, occupying almost all of the anterior width of dorsum, as figured. The Standard Data from four specimens are as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	110·25 – 1·98	3·96 ± 1·4	98·35–122·15	104·0–115·0	3·6
PW	125·5 ± 1·09	2·18 ± 0·77	119·0–132·0	122·0–128·0	1·72
SB	62·0 ± 0·61	1·73 ± 0·43	56·8–67·2	61·0–65·0	2·4
SD	66·0	No variation recorded			
A–P	36·75 ± 0·65	1·30 ± 0·45	32·85–40·65	36·0–39·0	3·5
AM	46·25 ± 0·65	1·30 ± 0·45	42·35–50·15	44·0–47·0	2·8
AL	47·0	No variation recorded			
PL	58·0	No variation recorded			
Sens.	61·0	No variation recorded			

Dorsal scutum pitted in transverse rows, setae thick, blunt-ended and strongly ciliated. Eyes 2 + 2. Mandibles and palpi normal. Chelicerae as figured. Dorsal setae thick, apically blunt and strongly ciliated, arranged 2.6.6.4.2.2. Legs

relatively long, I 324 μ, II 288 μ, III 324 μ; tarsi I and II with long stout sensory rod as figured; tibiae I and II dorsally with a similar but shorter rod and another rod which is pointed; tarsi with stout paired claws and a longer, more slender empodium. Venter: gnathosoma with transverse lines of pits and a pair of long

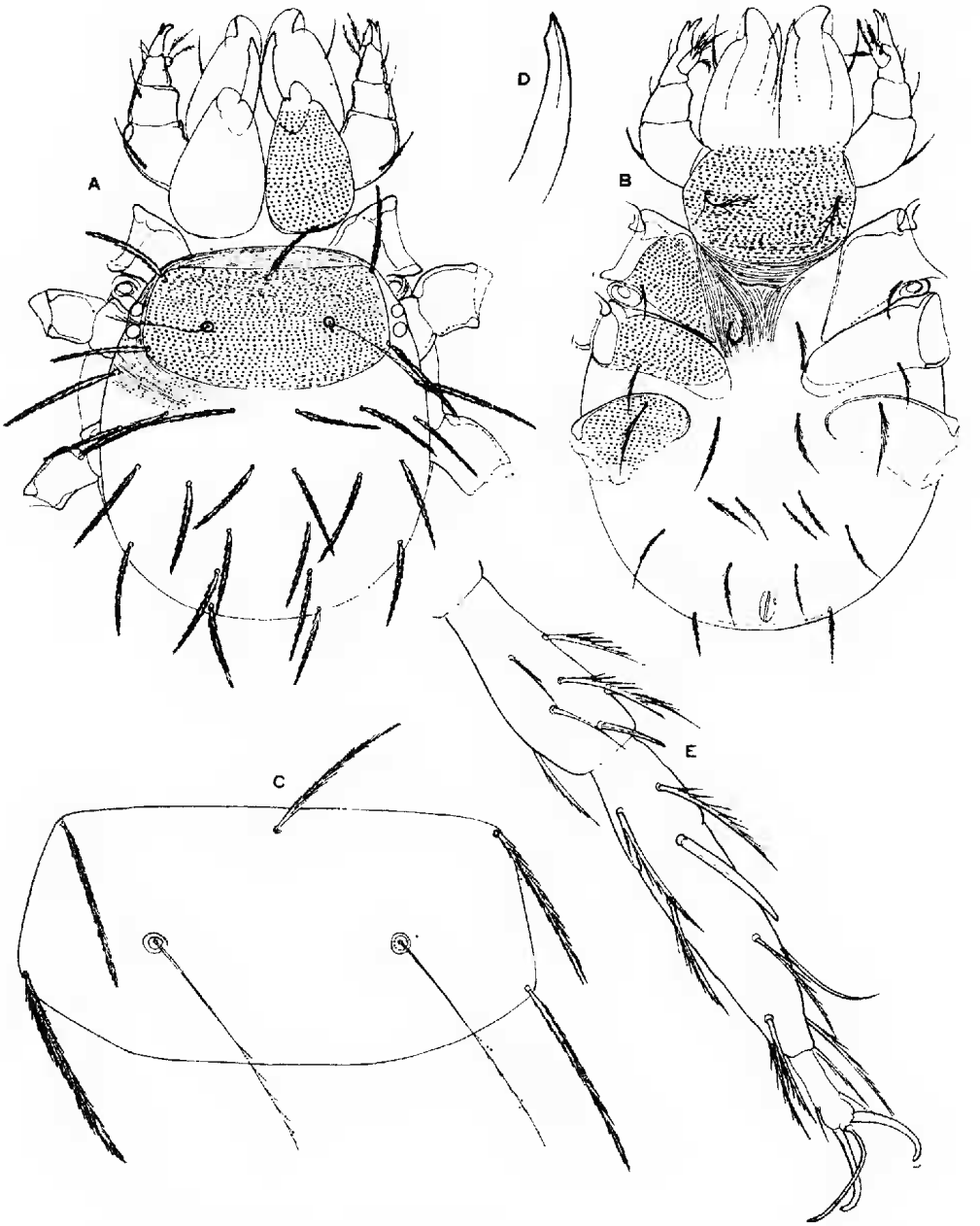


Fig. 4 *Trombicula kohlsi* n. sp. Larva: A, dorsal; B, ventral; C, scutum x 500; D, chelicera; E, tarsus and metatarsus I.

ciliated setae; all coxae unisetose; a pair of long ciliated setae between coxae I and between coxae III, and thereafter the setae are arranged 4.4.2, these are tapering and not so thickly ciliated as the dorsal setae; all coxae with lines of pits but the cuticle otherwise striated. Anus at extreme end of venter.

Locality—A small number of specimens collected on shoes from amongst Kunai grass, Buna area, New Guinea, November 1943 (G. M. Kohls).

Remarks—In the DS this species belongs to the *minor* group, but differs conspicuously in the large and wide dorsal scutum, which would place it at the end of the key (*loc. cit.*, 75) to the larvae of this genus, and in caption 28, together with *samboni* Wom. and *macropus* Wom.

TROMBICULA WALCHI Wom. and Heasp. 1943

Trans. Roy. Soc. S. Aust., **67**, (1), 83, 1943.

This species occurs commonly in parts of New Guinea along with the following species, *T. fletcheri* W. and H. The DS are arranged 2.8.6.6.4.2 and the ventral setae 4.6.4.4.2.

Beside the type and paratype, 16 specimens from the Buna and Abidari areas of New Guinea have been examined and the following statistics of the Standard Data calculated.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	60·5±0·36	1·54±0·26	55·9–65·1	58·0–65·0	2·5
PW	68·2±0·55	2·32±0·39	61·2–75·2	65·0–75·0	3·4
SB	28·65±0·23	1·00±0·16	25·6–31·6	26·0–30·0	3·5
SD	38·5±0·68	2·89±0·48	29·8–47·2	33·0–43·0	7·5
A–B	26·7±0·62	2·65±0·46	18·8–34·6	25·0–32·0	9·9
AM	43·1±0·86	3·54±0·60	32·5–53·7	40·0–52·0	8·2
AL	35·0±0·36	1·53±0·25	31·0–40·2	32·0–39·0	4·3
PL	42·4±0·96	4·07±0·68	30·2–54·6	40·0–54·0	9·6
Sens.	60·3±0·65	2·05±0·46	54·1–66·4	56·0–65·0	3·4

TROMBICULA FLETCHERI Wom. and Heasp. 1943

Trans. Roy. Soc. S. Aust., **67**, (1), 86, 1943.

The DS in this species are arranged 2.10.8.6.4.2 to 2.10.8.8.6.4.2, *i.e.*, 32-38 as compared with only 28 in *T. walchi*. The ventral setae are arranged ca. 8.8.8.6.4.4.2.

Of this species, which occurs along with the preceding, 13 specimens have been carefully measured, and the statistics for the Standard Data estimated as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	67·8±0·79	2·87±0·56	59·2–76·4	62·0–72·0	4·2
PW	77·2±0·65	2·29±0·45	70·4–83·0	73·0–79·0	2·9
SB	32·1±0·41	1·49±0·28	27·6–36·6	30·0–36·0	4·6
SD	40·2±0·76	2·76±0·54	31·9–48·5	34·0–44·0	6·8
A–P	28·3±0·58	2·09±0·41	22·0–34·6	25·0–32·0	7·4
AM	52·0±0·89	3·08±0·63	42·8–61·2	45·0–56·0	5·9
AL	37·5±0·57	1·98±0·40	31·6–43·0	35·0–40·0	5·3
PL	51·1±1·24	4·48±0·88	37·7–64·5	43·0–57·0	8·8
Sens.	64·4±0·57	1·80±0·40	59·0–69·8	62·0–68·0	2·8

Remarks—A calculation of the Standard Error of the Difference of Means of the populations of this and the preceding species shows clearly that the two species are distinct and that the two groups cannot belong to the same population. The values of d/σ_d for all the items AW, PW, SB, AM, AL, PL, and Sens. are >2, but SD and A-P both show an insignificant value of $<2{\cdot}0$.

The statistical evidence from the Standard Data therefore confirms the separation of the two species based on the DS.

Trombicula deliensis Walch 1923

Kitasato Arch Exper. Med., **5**, (3,) 63, 1923; Tr. 5th Bien. Congr. Far East. Assoc. Trop. Med., Singapore, 1923 (publ. 1924).
Trombicula vanderghinstei Gunther 1940, Proc. Linn. Soc. N.S.W., **65**, (3-4), 252.
Trombicula deliensis Wom. and Heasp. 1943, Trans. Roy. Soc. S. Aust., **67**, (1), 87.

This is one of the most abundant species both in New Guinea and in Queensland. It was originally described from Sumatra, and Mehta's record (1937) of "*T. deliensis*" as associated with scrub typhus in the Simla Hills may be correct.

From information available from both Queensland and New Guinea this species is probably one of the few which seem, so far, to be somewhat more definitely associated with scrub typhus in those areas.

Morphologically the species is well separated by the DS being 2.8.6.6.4.2, and by the "Standard Data." Since the original "Standard Data" was published, collections have been received from the Buna and Milne Bay area of New Guinea. These collections, together with the original lot from Cairns, Queensland, and the small lot from Bulolo, New Guinea, described by Gunther as *vanderghinstei*, have been studied statistically and separately. The difference between the various pairs of populations have been tested for significance by taking the value of d/σ_d

The Standard Data for the individual populations are as follows:

Cairns—Number of specimens = 20.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	63·15±0·50	2·24±0·35	56·4–69·8	60·0–67·0	3·5
PW	76·95±0·75	3·38±0·53	66·8–87·0	70·0–82·0	4·4
SB	29·9±0·34	1·53±0·24	25·3–34·5	26·0–32·0	5·1
SD	37·2±0·43	1·94±0·30	31·4–43·0	35·0–41·0	5·2
A–P	28·4±0·28	1·28±0·20	24·6–32·2	27·0–30·0	4·5
AM	55·9±0·49	2·15±0·34	49·4–62·3	52·0–60·0	3·8
AL	43·6±0·49	2·20±0·35	37·0–50·2	40·0–48·0	5·0
PL	62·6±0·56	2·52±0·40	55·1–70·1	57·0–67·0	4·0
Sens.	62·8±0·52	2·09±0·37	56·5–69·1	60·0–65·0	3·3

Bulolo—Number of specimens = 4.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	65·0±0·47	0·82±0·33	62·6–67·4	64·0–66·0	1·25
PW	74·0±1·24	2·16±0·81	67·5–80·5	71·0–76·0	2·9
SB	29·3±0·98	1·70±0·69	24·2–34·4	27·0–31·0	5·8
SD	39·7−1·26	2·18±0·89	33·2–46·2	36·0–40·0	5·5
A–P	27·5±0·75	1·50±0·53	23·0–32·0	26·0–30·0	5·4
AM	54·2±1·82	3·63±1·28	43·3–65·2	50·0–60·0	6·7
AL	42·7−0·25	0·51±0·18	41·25–44·25	42·0–43·0	1·2
PL	61·7−0·74	1·48±0·52	57·25–66·25	60·0–64·0	2·4
Sens.	65·0	No variation recorded			

Milne Bay—Number of specimens = 22.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	67·2±0·57	2·69±0·40	59·2–75·2	61·0–72·0	4·0
PW	84·2±1·32	6·20±0·93	65·6–102·8	72·0–93·0	7·3
SB	32·2±0·43	2·02±0·30	26·2–38·2	29·0–36·0	6·2
SD	40·0±0·41	1·94±0·29	34·2–45·8	39·0–44·0	4·8
A–P	30·4±0·25	1·13±0·18	27·0–33·8	29·0–32·0	3·7
AM	52·8±0·48	2·25±0·34	46·0–59·6	47·0–57·0	4·2
AL	42·3±0·31	1·45±0·22	38·0–46·6	40·0–45·0	3·4
PL	58·0±0·63	2·95±0·44	49·0–67·0	50·0–65·0	5·0
Sens.	63·0±0·61	2·54±0·44	55·4–70·6	61·0–68·0	4·0

Buna—Number of specimens = 7.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	70·4 ± 0·69	1·84 ± 0·49	64·9–75·9	68·0–72·0	2·6
PW	83·7 ± 1·07	2·86 ± 0·76	75·1–92·3	79·0–86·0	3·4
SB	32·8 ± 0·91	2·41 ± 0·64	25·6–40·0	29·0–36·0	7·3
SD	41·85 ± 1·30	3·35 ± 0·89	31·8–51·8	39·0–47·0	8·0
A–P	30·3 ± 1·04	2·76 ± 0·74	22·0–38·6	25·0–32·0	9·1
AM	67·6 ± 0·96	2·55 ± 0·68	60·0–75·2	65·0–72·0	3·8
AL	55·3 ± 0·56	1·48 ± 0·40	50·8–59·8	54·0–57·0	2·7
PL	86·4 ± 1·47	3·90 ± 1·04	74·7–98·1	83·0–94·0	4·5
Sens.	69·7 ± 1·30	3·45 ± 0·92	59·35–80·0	62·0–72·0	5·0

The significance of the differences between these populations, taking a value of $d > 2\sigma_d$ as being positively significant, is shown in the following table.

Table of Significance of Four Populations of *T. deliensis*

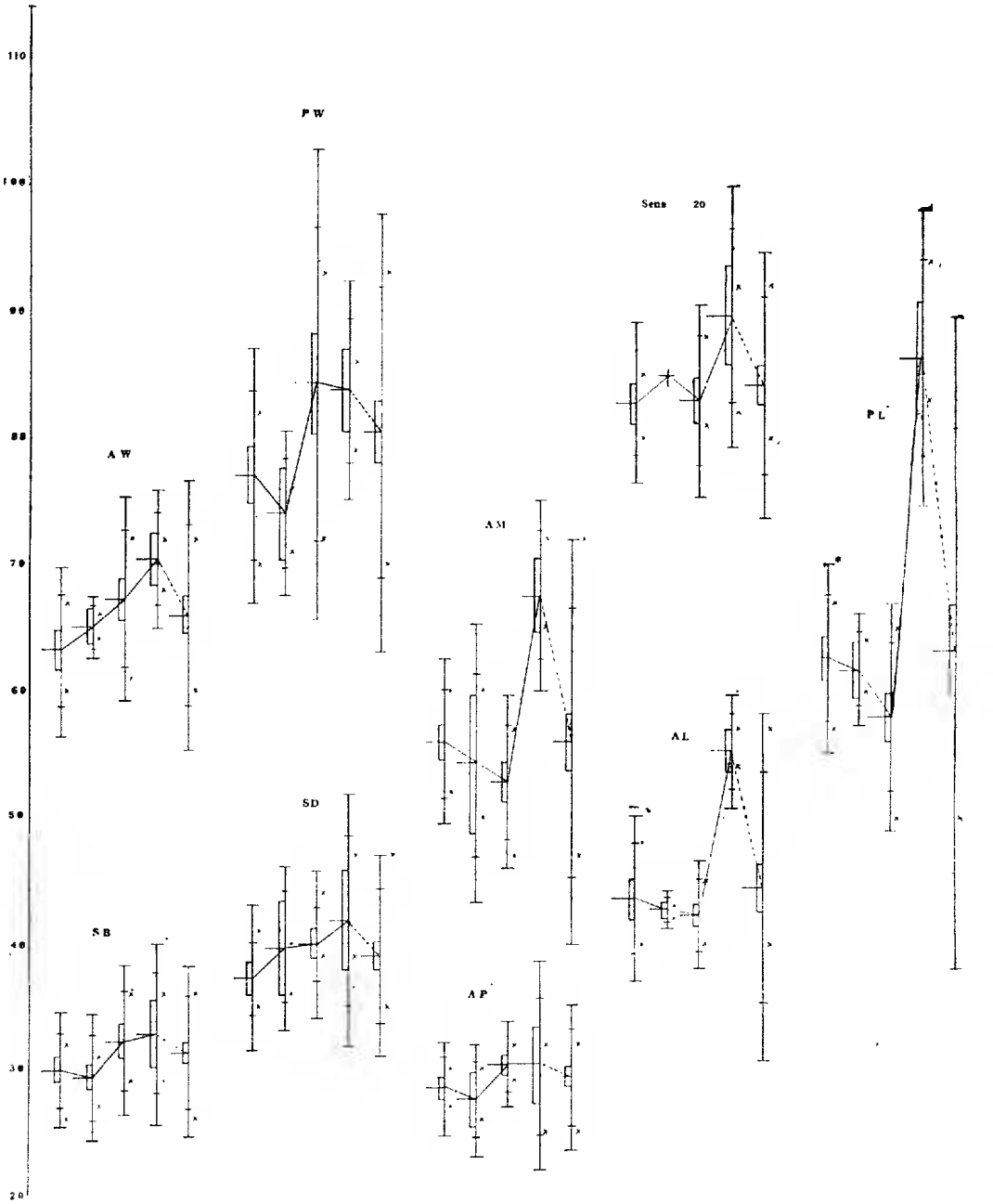
	AW	PW	SB	SD	A-P	AM	AL	PL	Sens.
Cairns-Buna	+	+	+	+	+	+	+	+	+
Cairns-Milne Bay	+	+	+	+	+	+	+	+	–
Cairns-Bulolo	–	–	–	+	±	–	–	–	–
Buna-Milne Bay	+	–	–	–	–	+	+	+	–
Buna-Bulolo	+	+	±	–	–	+	+	+	±
Milne Bay-Bulolo	–	+	±	–	+	–	–	±	–

It is seen that while the Cairns population shows a significant difference from, and might conceivably be separated from those of Buna and Milne Bay, yet they are linked together by the Bulolo population. *T. deliensis* is, then, rather a widely variable species, and for specific identification the range of variation of the Standard Data as given by the four above populations *combined* must be taken into account. It is also to be noticed that the statistics for AM, AL and PL of the Buna populations are markedly higher than for the other populations, and this may indicate a tendency for a genetical separation in this locality. The statistics of the "Standard Data for the combined populations are as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	65·9 ± 0·50	3·58 ± 0·35	55·2–76·6	60·0–72·0	5·4
PW	80·3 ± 0·80	5·77 ± 0·57	63·0–97·6	70·0–93·0	7·2
SB	31·3 ± 0·31	2·28 ± 0·22	24·5–38·1	26·0–36·0	7·3
SD	39·0 ± 0·37	2·67 ± 0·26	31·1–47·1	35·0–47·0	6·8
A–P	29·4 ± 0·26	1·93 ± 0·19	23·6–35·2	25·0–32·0	6·5
AM	56·0 ± 0·74	5·30 ± 0·52	40·0–72·0	47·0–72·0	9·5
AL	44·0 ± 0·63	4·57 ± 0·44	30·7–58·3	40·0–57·0	10·0
PL	63·3 ± 1·20	8·78 ± 0·85	37·0–89·6	50·0–94·0	5·4
Sens.	64·2 ± 0·52	3·48 ± 0·37	53·7–74·7	60·0–72·0	5·4

The accompanying graphs of the parameters for each particular character of the different populations give a more visual picture of the variations within the species.

Each measurement, *e.g.*, AW, PW, etc., in microns is shown separately for the four populations in the order from left to right of Cairns, Bulolo, Milne Bay and Buna. The Means for each are linked together, and to the right again is a graph showing the statistics considering the four populations as one. The statistics shown are: Mean $\pm 3\sigma_M$, theoretical range as expressed by Mean $\pm 3\sigma$, the value of Mean $\pm 2\sigma$, and the observed range (indicated by x, x). To save space the graph of Sens. has been increased 20 μ, so that this must be allowed for in reading.



Graphs showing Variation in Statistics of Standard Data of four populations of larval *Trombicula deliensis* Walch.

(Measurements in microns, except Sens., to which 20 μ has been added to save space. Populations from left to right in each set are from Cairns, Bulolo, Milne Bay and Buna, followed by the combined graph.)

TROMBICULA MINOR Berl. 1904

Trombicula minor Berl. 1905, Acari Nuovi, Manip. IV, 135; Womersley 1939 (July), Trans. Roy. Soc. S .Aust., **63**, (2), 152; Gunther 1939 (December), Proc. Linn. Soc. N.S.W., **64**, (51-6), 466; *ibid.*, **65**, (5-6), 477; Womersley and Heaslip 1943, Trans. Roy. Soc. S. Aust., **67**, (1), 92.

Trombicula pseudoakamushi v. *deliensis* Walch 1924, Tr. 5th Bien. Congr. Far East. Assoc. Trop. Med., 601.

Trombicula hirsti Sambon 1927, Ann. Mag. Nat. Hist., (9), **20**, 157; *nec* Hirst 1929, *ibid.*, (10), 3, 564; *nec* Womersley 1934, Rec. S. Aust., **5**, (2), 212; Gate 1932, Parasitology, **24**, 143.

Trombicula hirsti v. *morobensis* Gunther 1938 (*nom. nud.*), Med. J. Aust., **2**, (6), 202.

Trombicula hirsti v. *buloloensis* Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1-2), 78.

Trombicula minor v. *deliensis* Wom. and Heasp. 1943, Trans. Roy. Soc. S. Aust., **67**, (1), 93.

Of this species, which is common in parts of New Guinea and Queensland, separate populations for each area (New Guinea 23 specimens, Queensland 50 specimens) have been examined with the following results:

Queensland.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	83·4±0·38	2·69±0·27	75·3–91·4	75·0–90·0	3·2
PW	96·6±0·37	2·63±0·26	88·7–104·5	90·0–104·0	2·7
SB	42·8±0·21	1·52±0·15	38·3–47·3	40·0–47·0	3·5
SD	67·7±0·33	2·35±0·23	60·7–74·7	61·0–72·0	3·4
A–P	35·9±0·17	1·21±0·12	32·3–39·5	32·0–39·0	3·4
AM	40·6±0·33	2·33±0·24	33·6–47·6	34·0–47·0	5·7
AL	45·9±0·33	2·35±0·23	38·9–53·0	40·0–50·0	4·1
PL	54·1±0·28	2·00±0·20	48·1–60·1	47·0–60·0	3·7
Sens.	64·4±0·57	3·08±0·40	55·2–73·7	51·0–68·0	4·8

New Guinea.

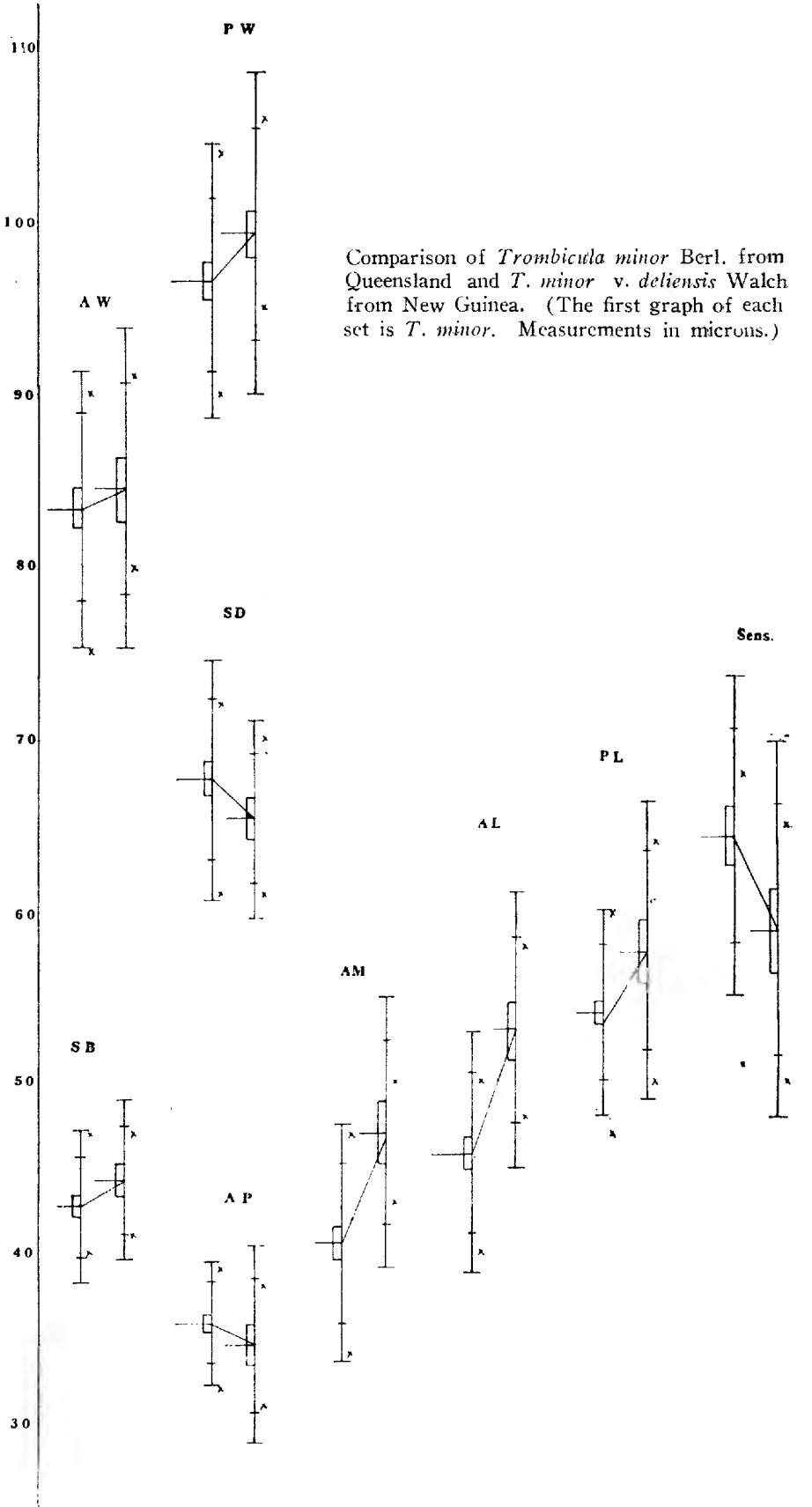
	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	84·5±0·64	3·06±0·45	75·3–93·7	80·0–91·0	3·6
PW	99·3±0·46	3·10±0·33	90·0–108·6	95·0–106·0	2·2
SB	44·3±0·33	1·58±0·23	39·6–49·0	41·0–47·0	3·5
SD	65·4±0·41	1·89±0·29	59·7–71·7	61·0–70·0	2·9
A–P	34·6±0·40	1·93±0·28	28·8–40·4	31·0–38·0	5·7
AM	47·1±0·60	2·68±0·42	39·1–55·1	43·0–50·0	5·7
AL	53·1±0·56	2·72±0·40	45·0–61·2	48·0–58·0	5·1
PL	57·7±0·60	2·89±0·43	49·0–66·4	50·0–64·0	5·0
Sens	58·9±0·81	3·65±0·57	48·0–69·9	50·0–65·0	6·2

Comparing these two populations in which the ranges of variation but not the ranges of Means, except for AW and SB, overlap considerably, it is found that, taking the standard error of the difference of means, they are significantly different for all characters except AW, the values for d/σ_d being AW 1·48, PW 4·37, SB 4·05, SD 4·0, A-P 3·5, AM 10·0, AL 11·6, PL 6·8, Sens. 5·7.

Further, the ratio of PW/SD differs considerably, as follows: Queensland 1·427, New Guinea 1·519.

It seems reasonable therefore that, while both populations may belong to the same species, and there is not sufficient difference to regard the New Guinea (and Sumatran) material (previously recorded as *T. minor* v. *deliensis* Walch) as a distinct variety, yet there is a geographical genetical difference between the two populations.

The two closely allied species, *T. wichmanni* Oudms. and *T. hatorii* Wom. and Heasp. are not known from sufficient material but appear to be significantly different, in the Standard Data, and in the ratio of PW/SD which for *wichmanni* is 1·85 and for *hatorii* 1·57.



Comparison of *Trombicula minor* Berl. from Queensland and *T. minor* v. *deliensis* Walch from New Guinea. (The first graph of each set is *T. minor*. Measurements in microns.)

Trombicula sarcina n. sp.

Fig. 5, A–C

Description—Larva. Shape shortly oval. Length 25 μ, width 160 μ. Dorsal scutum as figured with the following Standard Data in microns: AW 79, PW 90, SB 36, ASB 25, PSB 32, SD 57, A-P 32, AM 26, AL 34, PL 40, Sens. ? Dorsal setae 26 in number, arranged 2.6.6, then two well separated clusters of 6 on each

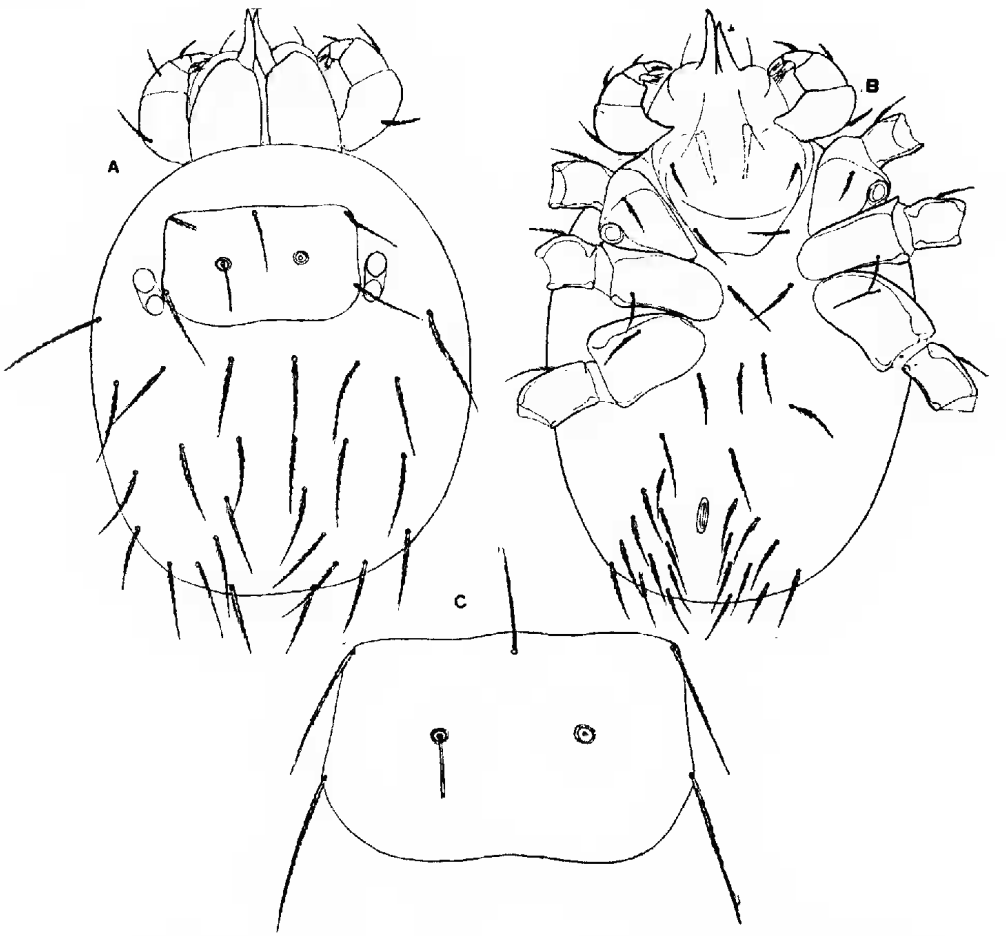


Fig. 5 *Trombicula sarcina* n. sp. Larva: A, dorsal; B, ventral; C, scutum x 500.

side (see fig. 5 A), 40-47 μ long, fairly robust and well ciliated. Eye 2 + 2. Palpi and mandibles typical of the genus. Venter: gnathosoma with a pair of ciliated setae, a pair between coxae I and between coxae III, thereafter 4.2, and then a pair of clusters of 9 to 10 each as on the dorsum (fig. 5 B). All coxae unisetose. Legs: I 270 μ, II 250 μ, III 290 μ; tarsi I and II with dorsal rod-like seta; all tarsi with paired claws and claw-like empodium.

Locality and *Host*—A single specimen (one of two) found in lesions on the skin about the shanks and coronets of sheep, Clermont, Queensland, March 1944 (sent by Mr. D. A. Gill, McMaster Laboratory, Sydney). Eight specimens collected on boots in ti-tree sheep camp, Clermont, Queensland, April 1944.

Remarks—This species is rather closely related to *T. minor* in the general conformation of the scutum but differs in the length of AM, AL, and PL, and

more particularly in the greater number of DS, and their arrangement posteriorly into two well separated lateral clusters. The sensillae are missing except for a short piece of one, but long enough to place the species in *Trombicula*. With the eight specimens from Clermont, Queensland, received after the above description was drawn up the Standard Data are as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	77·0±0·63	1·9±0·44	71·35–82·65	75·0–79·0	2·45
PW	88·65±0·57	1·7±0·40	83·55–93·75	85·0–90·0	1·91
SB	40·1±0·85	2·55±0·60	32·5–47·7	36·0–43·0	6·3
SD	57·0	No variation recorded			
A-P	57·0	No variation recorded			
AM	29·0±0·47	1·41±0·33	24·8–33·2	26·0–32·0	4·85
AL	35·8±0·21	0·63±0·15	33·9–37·7	34·0–36·0	1·8
PL	42·7±0·31	0·94±0·22	39·9–45·5	40·0–43·0	2·2
Sens.	57·0	No variation recorded			

Genus SCHÖNGASTIA Oudemans 1910

Entom., Ber., 1910, **3**, (54), 86.

Schongastia pusilla n. sp.

Fig. 6, A–C

Description—Larvae. Colour in life probably light yellowish-red. Shape ovoid. Length to 210 μ, width to 155 μ. Dorsal scutum typical of the genus, as figured, and with the following Standard Data as derived from 28 specimens.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	54·85±0·48	2·57±0·34	47·1–62·5	50·0–61·0	4·7
PW	72·7±0·51	2·72±0·36	64·5–80·8	68·0–79·0	3·7
SB	21·25±0·21	1·13±0·15	17·85–24·65	19·0–23·0	5·3
SD	50·6±0·47	2·34±0·33	43·6–57·6	44·0–57·0	4·6
A–P	25·45±0·31	1·68±0·22	20·4–30·5	23·0–32·0	6·6
AM	30·4±0·30	1·50±0·21	25·9–34·9	28·0–32·0	5·0
AL	57·5±0·54	2·87±0·39	48·9–66·1	54·0–61·0	5·0
PL	44·2±0·70	3·63±0·49	33·3–55·1	39·0–50·0	8·2
Sens.	Nude, ca. 33 μ long, with head 24 μ x 24 μ				

Dorsal setae slender, tapering and ciliated, and arranged 2.8.2 (outer). 8.8.6.2.2. Eyes 2 + 2. Mandibles and palpi normal for genus. Legs: I 250 μ long, II 210 μ, III 235 μ; tarsi with paired claws and median claw-like empodium; tarsi I and II with the usual sensory dorsal rod. Venter: all coxae unisetose; between coxae I and between coxae III with the usual pairs of similar setae; thereafter the setae are arranged approximately 2.6.6.6(4).4(2). (2).

Locality—In numbers, collected on boots in Kunai grass, Buna area of New Guinea, 1943, together with *S. blestowei* Gunther and *T. walchi* Wom. and Heasp.

Remarks—This is rather a small species and in the key (Trans. Roy. Soc. S. Aust., **67**, (1), 102) comes near to *S. katonis* Wom. and Heasp. but can be distinguished by the Standard Data and arrangement of DS, and the nude head of the sensillae. As it might also be confused with *S. blestowei*, with which it occurs, the Standard Error of the Difference of the Means for both species have been compared and found to be significant (see under *S. blestowei*).

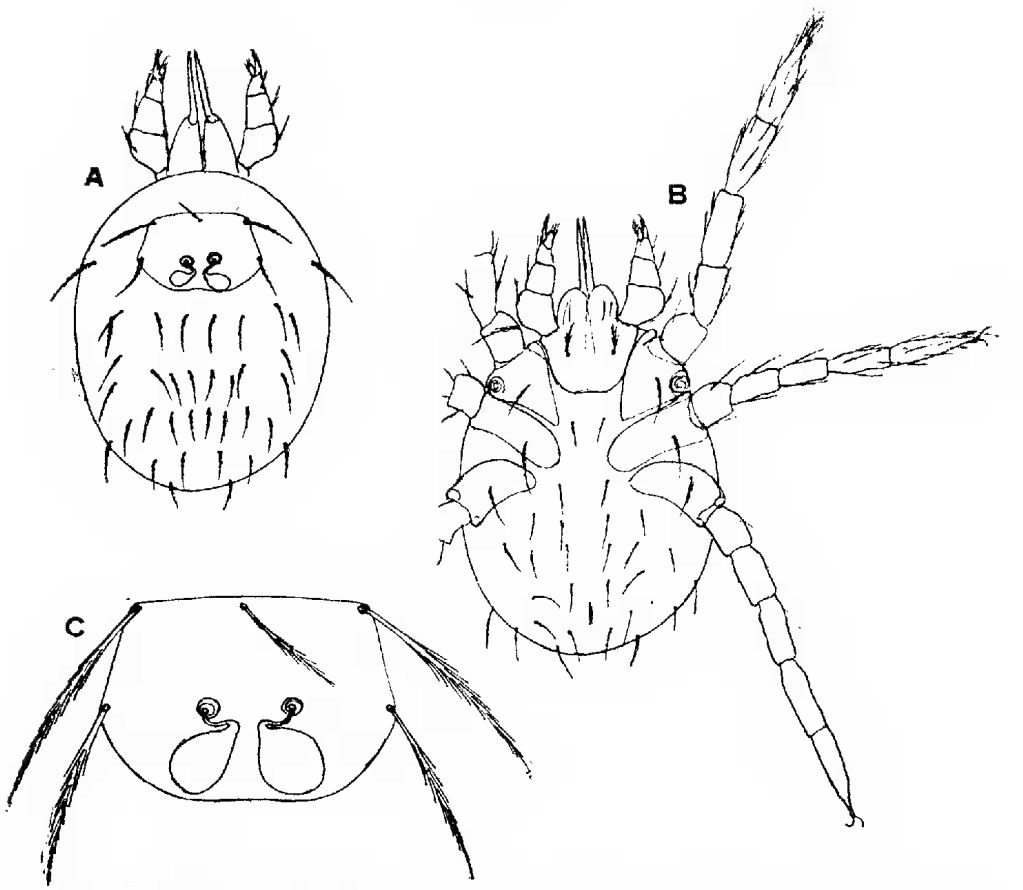


Fig. 6 *Schöngastia pusilla* n. sp. Larva: A, dorsal; B, ventral; C, scutum x 500.

SCHÖNGASTIA BLESTOWEI Gunther 1939

Schöngastia yeomansi Gunther 1938, Med. J. Aust., 2, (6), 202, (nom. nud.); *blestowei* Gunther 1939, Proc. Linn. Soc. N.S.W., 64, (1, 2), 92; Womersley and Heaslip 1943, Trans. Roy. Soc. S. Aust., 67, (1), 103.

Of this species, which so far is only known from New Guinea, I am now able to report on three populations from different areas, *viz.*, Suein River, Sepik District (7 specimens from man); 3 specimens from Bulolo from *Megapodius duperreyi;* and 32 specimens collected on boots, Buna area. The Standard Data for the first two populations were reported in 1943, but are now examined statistically with those of the Buna collection.

Buna—Number of specimens = 32.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	67·6±0·80	5·0±0·62	52·6–82·6	61·0–79·0	7·4
PW	88·8±0·70	3·95±0·49	77·0–100·5	82·0–97·0	4·4
SB	27·25±0·35	1·97±0·25	21·2–33·3	25·0–29·0	6·5
SD	67·1±0·77	4·27±0·54	54·3–79·9	56·0–75·0	6·4
A–P	32·7±0·35	1·97±0·25	26·8–38·6	29·0–36·0	6·0
AM	39·5±0·40	2·16±0·76	33·0–46·0	35·0–43·0	5·5
AL	77·8±0·99	5·6±0·70	61·0–94·6	70·0–90·0	7·2
PL	59·6±0·85	4·8±0·60	45·5–74·1	50·0–72·0	8·0
Sens.	35·0	Not individually measured			

Suein River, Sepik District, on man. Number of specimens = 7.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	65·0	No variation recorded			
PW	89·3±0·66	1·75±0·47	84·0–94·5	87·0–91·0	1·95
SB	25·7±0·26	0·70±0·19	23·6–27·8	24·0–26·0	2·7
SD	60·4±0·75	1·99±0·53	54·4–66·4	58·0–65·0	3·3
A–P	30·0±0·28	0·75±0·20	27·75–32·25	29·0–31·0	2·8
AM	36·2±0·70	1·87±0·50	30·6–41·8	35·0–40·0	5·1
AL	65·0	No variation recorded			
PL	50·85±0·37	0·99±0·26	47·8–53·9	50·0–52·0	1·95
Sens.	35·0	No variation recorded			

Bulolo (ex *Megapodius*)—Number of specimens = 3

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	90·0±0·47	0·81±0·33	56·6–61·4	58·0–60·0	1·4
PW	90·0±0·47	0·91±0·33	77·0–83·0	78·0–82·0	1·4
SB	33·0±0·81	1·41±0·57	28·8–37·2	32·0–35·0	4·2
SD	62·0	No variation recorded			
A–P	20·0	No variation recorded			
AM	37·0	Only 1 specimen measured			
AL	63·0	Only 1 specimen measured			
PL	60·0±1·42	2·00±1·0	54·0–66·0	58·0–62·0	3·3
Sens.	30·0	No variation recorded			

The above three populations have been tested for significant differences and the results summarised in the following table, a value of $d/\sigma_d > 2$ being regarded as positive, those in the neighbourhood of 2·0 being indicated by ±.

Significance of Differences of three Populations of *Schöngastia blestowei* Gunther.

	AW	PW	SB	SD	A-P	AM	AL	PL
Buna-Suein Rv.	–	–	±	+	+	+	+	+
Buna-Bulolo	+	+	+	+	+	±	+	–
Suein Rv.-Bulolo	+	+	+	±	+	–	+	–

From this it is seen that the Bulolo specimens regarded in the 1943 paper as a variety *megapodius* of *blestowei* differ significantly from those of Suein River and Buna, but that the Suein River population only differs from the Buna population in the factors SD, A-P, AM, AL and PL.

That *megapodius* should be regarded as a distinct variety is also borne out by: (1) that its host is a bird *Megapodius duperreyi* and (2) that on the venter behind coxae III the setae number 26 arranged ca. 6.6.4.4.4.2, whereas in *blestowei* f. typ. they number 40, arranged approximately 8.8.8.6.4.4.2.

The ratios of the PW/SD of the three populations are Buna 1·32, Bulolo 1·29, Suein River 1·48. A comparison of the Standard Data of these populations with those of *S. pusilla* shows a positive difference in all characters, the values of d/σ_d in all cases greatly exceeding one of 2.

Schöngastia salmi Oudms. 1922

Ent. Bericht, 1922, **6**, (126), 81; *idem*, **6**, (128), 114.

This species, overlooked in the 1943 paper, was described from Java without any figure and with only the briefest description, a translation of which is as follows:

"Differs from hitherto described species in the form of the scutum, which is trapezoidal, wider behind than in front, anteriorly concave, posteriorly strongly convex with a deep medial incision. The posterior half of the scutum is finely wrinkled as is the dorsal cuticle. On the dorsum with 12 transverse rows of 10 ciliated setae.

"Living in grass; parasitic on ————? Kediri, (Java), Dr. A. J. Salm."

In a short additional note (above) Oudemans says, "Tenkoe des abres; in gras, Magelang, Sept. 1916."

There is, unfortunately, nothing in the above by which one can place the species in *Schöngastia, Neoschöngastia* or *Paraschöngastia,* except possibly the wrinkling (striations) of the posterior half of the scutum which perhaps suggests a member of the last genus. It seems, therefore, that until the type can be located and examined, the species must be regarded as "incertae sedis".

Genus NEOSCHÖNGASTIA Ewing 1929

Manual of External Parasites, 1929, 187.

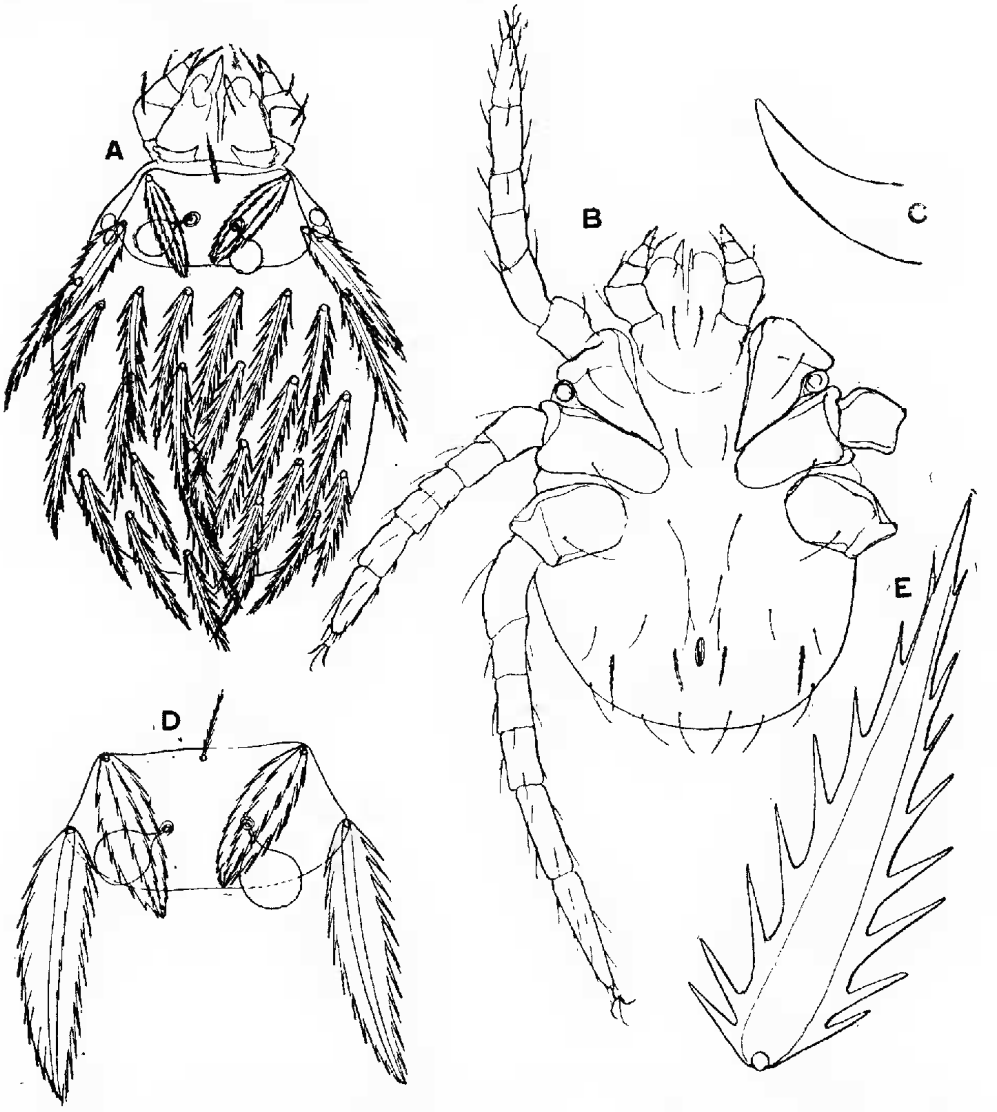


Fig. 7 *Neoschöngastia mccullochi* n. sp. Larva: A, dorsal; B, ventral; C, chelicera; D, scutum x 500; E, dorsal seta.

Neoschongastia mccullochi n. sp.

Fig. 7, A–E

Description—Larvae. Shape ovate. Length 170 μ, width 130 μ. Dorsal scutum as figured, with the following Standard Data in microns: AW 48, PW 67, SB 19, ASB 19, PSB 16, A-P 20, AM 16, AL 42, PL 64, Sens. 22 (head nude, 17 x 17). Dorsal setae 48 μ long, foliate with very large lateral teeth (cf. fig. 7 A) and arranged 2.6.6.6.4.2. The scutal AL and PL are similar to the DS in form; but AM is of normal form. Eyes 2 + 2, close to the margins of the scutum. Mandibles and palpi normal. Legs: I 248 μ long, II 208 μ, III 248 μ; tarsi with paired claws and median claw-like empodium. Venter: all coxae with 1 normal ciliated setae; a similar pair between coxae I and between coxae III, and thereafter arranged 2.6.4.4.2, the first row of 4 stronger and more ciliated than the rest.

Locality—A single specimen collected on boots, Abidari, New Guinea, 28 July 1943 (R. N. McCulloch).

Remarks—This species is close to *N. foliata* Gunther, but differs in the broader and stronger toothed DS, which are only 26 in number as compared with 32. Other differences lie in the smaller scutum and the Standard Data.

Genus GUNTHERANA Womersley 1943

Trans. Roy. Soc. S. Aust., 1943, 67, (1), 132.

Guntherana parana n. sp.

Fig. 8, A–B

Description—Larvae. Shape broadly oval, without a distinctive waist. Length to 195 μ, width to 143 μ. Anterior dorsal scutum rectangular as figured, with the following Standard Data based on seven specimens.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	46·7 ± 0·78	2·05 ± 0·55	40·6–52·8	43·0–50·0	4·4
PW	64·7 ± 1·00	2·65 ± 0·71	56·7–72·6	61·0–68·0	4·1
SB	17·4 ± 0·34	0·90 ± 0·24	14·7–20·1	16·0–18·0	5·2
SD	46·6 ± 0·4	1·05 ± 0·28	43·5–49·7	44·0–47·0	2·25
A–P	29·1 ± 0·51	1·35 ± 0·36	25·1–33·1	27·0–32·0	4·7
AM	30·0 ± 0·4	1·07 ± 0·28	26·8–33·2	29·0–32·0	3·5
AL	30·0 ± 0·4	1·07 ± 0·28	26·8–33·2	29·0–32·0	3·5
AL	74·0 ± 1·6	4·37 ± 1·17	60·9–87·1	68·0–81·0	5·9
PL	98·4 ± 1·6	4·34 ± 1·13	85·4–111·4	93·0–108·0	4·4
Sens.	No variation recorded				

The ratio of PW/SD = 1·39 and the ASB is slightly greater than PSB (19 : 16). Sensillae globose, the head nude and 16 x 16. Dorsal setae arranged 2.6.4.6.2, the last 2 being 90-120 μ long. Posterior dorsal scutum somewhat reniform, 104 μ wide, by 65 μ long, not subdivided, with very fine pitting (or pubesence) and with three pairs of very fine setae uniformly 31 μ long. Eyes 2 + 2. Mandibles and palpi normal as in *G. bipygalis* (Gunther). All coxae unisetose, a pair of setae between coxae I and between coxae III, and thereafter ventral setae 8.6.4.4.2. Legs: I 260 μ, II 235 μ, III 286 μ; tarsi with paired claws and a claw-like empodium; tarsi I and II with a short smooth sensorial rod dorsally.

Locality—A number of specimens collected on boots at Abidari, New Guinea, 28 July 1943 (R. N. McCulloch).

Remarks—Differs from the genotype in the smaller anterior dorsal scutum with different Standard Data, especially SB, and the fewer and different arrange-

ment of the DS (20 as compared with 28 in *bipygalis*). The posterior dorsal scutum also differs, the setae being uniform in length, whereas in *bipygalis* they are shorter and not uniform.

The remarkable habit of *G. bipygalis* of attaching its eggs to the fur of its host has not been observed for *G. parana*, neither has it yet been found upon any host.

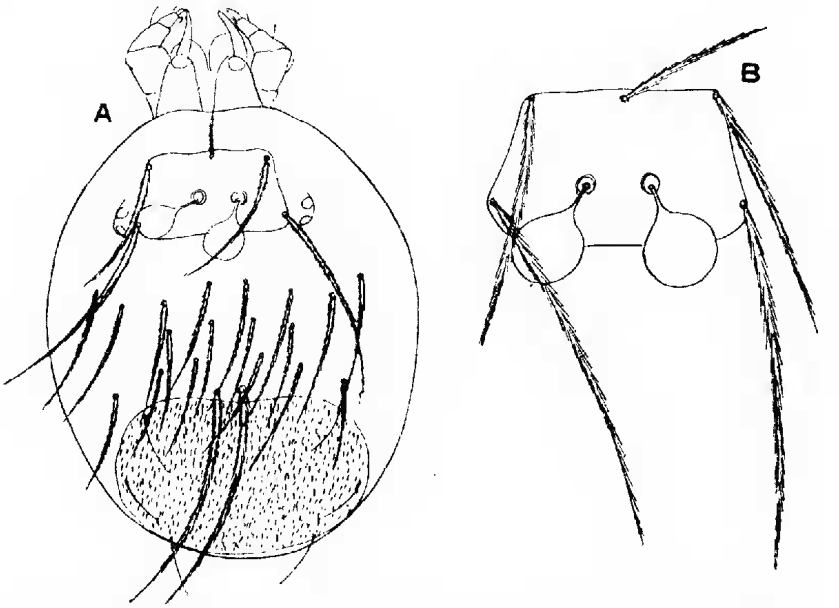


Fig. 8 *Guntherana parana* n. sp. Larva: A, dorsal; B, scutum x 500.

Genus WALCHIA Ewing 1931

Proc. U.S. Nat. Mus., **80**, (8), 10. Genotype *Walchium glabrum* Walch.

WALCHIA DISPARUNGUIS (Oudms. 1929)

= *Schöngastiella disparunguis* Ouds. 1929, Ent. Ber., 7, (165), 398.

This species was described from specimens from the ears of *Mus rattus* var. from Garoet (W. Java), Aug., W. C. van Heuren.

Oudemans' original description, translated, reads as follows:

"Length of a moderately engorged specimen 225 μ, greatest breadth 145 μ. Scutum roughly pentagonal with one angle directed posteriorly; in each of the other four angles a seta. On each shoulder is a seta and behind the scutum five rows of six setae in each. Pseudostigmal organ clavate, the stem about one-third of its length. Dorsal setae about 30 μ long, brush-like and shortly ciliated. Eyes small, cornea half-spherical. Venter: all coxae (also maxillae) with a feathered seta; coxae III with two such. Between coxae I and between coxae III a pair of similar setae. Then 17 pairs of setae similar to the dorsal setae. Gnathosoma dorsally with six pairs of smooth setae, ventrally with one more; externally on the tibiae with a short smooth seta, and on the very short and difficult to see palpus are four setae of which one is a short thick rod-like olfactory seta, the three others are short thick setae distally divided into four or five branches. Palpi claw bifid."

Oudemans was rather uncertain about placing this species in *Schöngastiella* Hirst as it differed from Hirst's diagnosis in having only four setae besides the sensillae on the scutum instead of three pairs. He also noted that the scutum resembles that of *Typhyothrombium* Ouds. 1910 (= *Gahrliepia* Ouds. 1912), but

in his description it is suggested that the posterior angle is sharply defined (not tongue-like as in *Gahrliepia* as now understood) and similar to that of *Walchia* Ewing.

Oudemans also refers to the disparity in form and size of the three tarsal claws, and named his species on this character. This feature, in which the median claw (empodium) is much stronger than the others and of median length, the outer longer and only slightly more slender, and the inner only slightly shorter than the median but much thinner, is, however, present in all the species of *Walchia* known to me and is, I believe, a good generic character.

The multisetose coxae III also places Oudemans' species in *Walchia,* but all other species have either one, three, four or six setae present and *disparunguis* is intermediate between *W. glabrum* Walch (= *pingue* Gater) with three coxal setae and the group, *morobensis* Gunther, *rustica* (Gater) and *turmalis* (Gater) with only a single seta on coxae III. In the DS it will be closely related to *glabrum.*

Walchia glabrum (Walch 1927)

Trombicula glabrum Walch 1927 Genesk., Tijdsch. v. Ned., Indie, **67,** (6), 926.
Walchia glabrum Ewing 1931, Proc. U.S. Nat. Mus., **80,** (8), 10; Womersley and Heaslip 1943, Trans. Roy. Soc. S. Aust., **67,** (1), 134.
Walchia pingue Gater 1932, Parasitology, **24,**

Of this species I have now been able to examine seven specimens from the Buna area of New Guinea, 1943 (G. M. Kohls). The statistical values of the Standard Data for these specimens are as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	29·3±0·26	0·70±0·19	27·2–31·4	28·0–30·0	2·4
PW	51·4±0·90	2·55±0·68	43·7–59·1	48·0–54·0	5·0
SB	26·85±0·55	1·46±0·39	22·5–31·2	25·0–29·0	5·4
SD	54·85±0·47	1·25±0·33	51·0–58·6	53·0–57·0	2·3
A–P	36·85±0·37	·98±0·37	33·9–39·8	36·0–38·0	2·7
AL	29·0	No variation recorded			
PL	33·4±0·52	1·4±0·37	29·2–37·6	32·0–35·0	4·2

In the 1943 paper, on page 135, it was stated that one of the lateral claws was wanting. I now find that this is not so, the inner claw is definitely present but fine and difficult to see, in comparison with the outer claw and empodium.

Subfam. **LEEUWENHOEKIINAE** nov.

Trombiculinae with a respiratory spiracle situated in front of the first coxae and on each side of the gnathosoma, from which radiate tracheal tubes.

A study of many specimens of *Leeuwenhoekia* has recently revealed the presence of the above pair of true spiracles, each of which is supplied with a tracheal system. The larvae of the Trombidiidae are separated from those of the Erythraeidae by the presence ventrally between the first and second coxae of a pronounced and conspicuous spiracle-like opening or "urstigma". No tracheal tubes, however, have ever been observed arising therefrom and its precise function is unknown. The above true stigma, however, is of a different type, smaller and less strongly chitinised, and long tracheae can be traced running down the body for a considerable distance.

On the presence of an organ of such fundamental importance it becomes necessary to erect a new family, ranking with the *Trombiculinae* in the restricted sense.

Unfortunately, the allied genus *Hannemannia* has not been found in this region and the presence of such an organ in the species of that genus requires determination by other workers. At present only the genus *Leeuwenhoekia* can be placed in the subfamily.

Genus LEEUWENHOEKIA Ouds. 1911

Entom., Ber., **3**, (5-8), 137. Genotype *Heterothrombium verduni* Ouds. 1910.

The first species of this larval genus to be recorded from Australia was *L. australiensis* Hirst 1925 (Trans. Roy. Soc. Trop. Med. and Hyg., 19), which was described from specimens collected in the suburbs of Sydney, where they were a source of much annoyance to people working in the gardens.

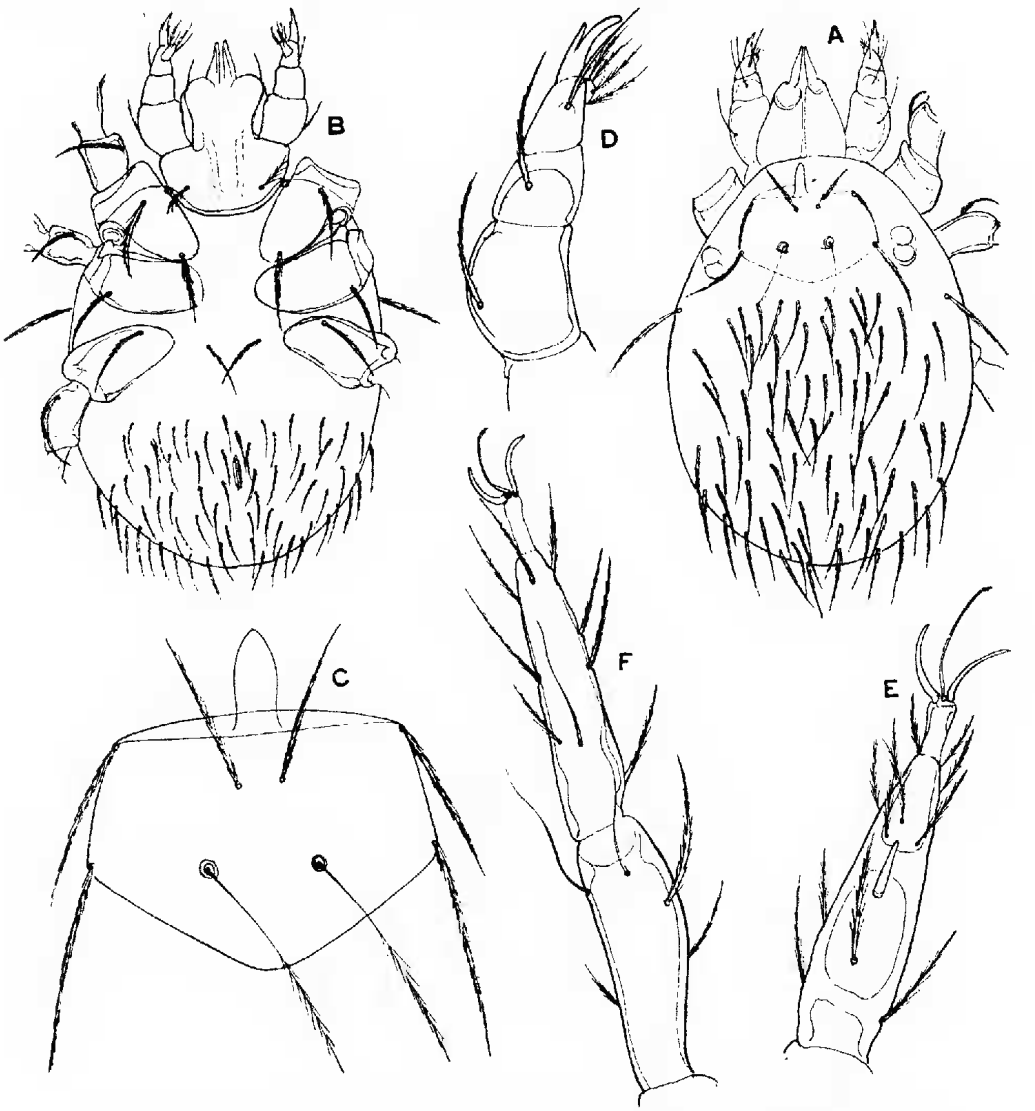


Fig. 9 *Leeuwenhoekia australiensis* Hirst. Larva: A, dorsal; B, ventral; C, scutum x 500; D, palp; E, tarsus I; F, tarsus and metatarsus IV.

In 1934 (Records S. Aust. Mus., **5**, (2), 217) I recorded, under the same name, specimens taken from the ears of a cat from Glen Osmond, Adelaide (D. C. S., 1931), and in 1939 (Proc. Linn. Soc. N.S.W., **64**, (1, 2), 95) Gunther

recorded it for New Guinea from a single specimen from a Cassowary at Bulolo, upon my determination.

In my joint paper with W. G. Heaslip (Trans. Roy. Soc. S. Aust., **67**, (1), 1943, 141) the Standard Data for a number of specimens from Queensland were also recorded.

It is now found that the Adelaide specimens are different and they are redescribed as a new species. Several other new species are also described and a key to the species of the genus presented.

Leeuwenhoekia australiensis Hirst

Fig. 9, A–F

Trans. Roy. Soc. Trop. Med. and Hyg. 1925, *nec* Womersley 1934. Rec. S. Aust. Mus. 1934, **5**, (2), 217; Gunther 1939, Proc. Linn. Soc. N.S.W., **64**, (1, 2), 95; Womersley and Heaslip 1943, Trans. Roy Soc. S. Aust., **67**, (1), 141 (in part).

A population of 13 specimens from Chatswood, Sydney, practically the type locality, collected in April 1943 (R. N. McCulloch), have been examined together with four from Cairns, Queensland, 1939, on bandicoots (W. G. Heaslip); four from bandicoots, Brisbane, Queensland, 1938, (W. G. H.), one from the same host, Little Mulgrave, Queensland, and one from man, Brisbane, Queensland, 1935 (F. H. S.). Both the Queensland and Sydney populations showed no significant differences in any of the characters used for the Standard Data.

Another specimen from Bulolo, New Guinea, collected by Gunther does, however, show a slight and significant difference from the Australian specimens in that the AL and PL are longer. It cannot, however, be regarded as more than a minor geographical difference.

In his original description Hirst gives the following data: scutal length 60 μ, width 96 μ; length of anterior scutal process 21 μ; AM 40-45 μ AL 46 μ, PL 63 μ DS 42-43 μ. The DS, according to his figures, are arranged ca. 2.10.7.10.12.11.8.6.4 = 70.

A fresh description is now drawn up from the Chatswood, Sydney, material, except that the Standard Data is from the Sydney and Queensland material combined.

Description—Length (excluding gnathosoma) to 340 μ, width to 230 μ. Shape an elongate oval. Dorsal scutum as figured, with following Standard Data:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	77·35 ± 0·98	4·73 ± 0·70	63·25–91·45	72·0–90·0	6·1
PW	93·4 ± 1·0	4·78 ± 0·70	79·1–107·7	86·0–102·0	5·1
SB	30·2 ± 0·43	2·06 ± 0·30	24·1–36·3	25·0–36·0	6·8
SD	70·8 ± 0·73	3·51 ± 0·52	60·3–81·3	63·0–77·0	5·0
A-P	31·9 ± 0·64	1·76 ± 0·45	26·6–37·2	29·0–36·0	9·7
AM	44·9 ± 0·68	3·27 ± 0·48	35·1–54·7	40·0–50·0	7·3
AL	49·0 ± 0·67	3·21 ± 0·47	39·4–58·6	45·0–58·0	6·5
PL	63·6 ± 0·57	2·75 ± 0·40	55·4–71·8	58·0–70·0	4·3
Sens.	64·0 ± 0·71	2·77 ± 0·50	55·7–72·3	61·0–68·0	4·3

Ratio of ASB/PSB = 41/30 and PW/SD = 1·32.

Dorsal setae about 76 in number, 45-60 μ long and arranged approximately 2.12.8.8.12.12.10.6.4.2. Anterior median projection of scutum 25 μ long by 14 μ wide at base. The AM setae are 12 μ apart at bases and placed about 21 μ behind the anterior margin of scutum. Eyes 2 + 2. Legs: longer than body, I 395 μ, II 310 μ, III 410 μ, including coxae; coxae I with two setae, II and III with one

seta, these setae 40 μ long; tarsi I and II with a stout dorsal sensory rod; all tarsi with paired claws and a longer median claw-like empodium; tibiae III with a pair of long slender whip-like setae and tarsi III with one such. Palpi and mandibles normal, chelae serrated. Gnathosoma with a pair of ciliated setae. Between gnathosoma and coxae 1 on each side is a distinct, lightly chitinised stigma from which tracheal tubes run; between coxae I and coxae II on each side is the larger, more chitinised pseudo-stigmata (urstigma) from which no tracheal tubes arise, and which is characteristic of all larval Trombidiidae. Ventrally, between coxae I, there are no setae, a pair between coxae III, and thereafter about 60 setae, to 60 μ long.

Locality and Hosts—As given in the introduction of this species.

Remarks—The Standard Data for the single specimen from Bulolo, New Guinea, are as follows:

AW	PW	SB	ASB	PSB	SD	A-P	AM	AL	PL	Sens.
83	97	32	43	32	32	30	54	61	72	60

As stated above, it is only significantly different in the values for AL and PL, and agrees in all morphological characters. Pending more material from Bulolo, it can only be regarded as a geographical variation.

Leeuwenhoekia adelaideae n. sp.

Fig. 10, A–C

Description—Larvae. Shape elongate oval. Length to 360 μ, width to 210 μ. Dorsal scutum as figured, and the Standard Data based on the South Australian material as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	76·4 ± 0·88	1·96 ± 0·62	70·5–82·3	74·0–80·0	2·5
PW	92·4 ± 0·53	1·20 ± 0·38	88·8–96·0	90·0–93·0	1·3
SB	28·8 ± 0·65	1·47 ± 0·46	24·4–33·2	26·0–30·0	5·1
SD	69·2 ± 0·18	·40 ± 0·12	68·0–70·4	69·0–70·0	·5
A–P	32·8 ± 0·18	·40 ± 0·12	31·6–34·0	32·0–33·0	1·2
AM	41·2 ± 0·65	1·47 ± 0·46	36·8–45·6	40·0–43·0	3·6
AL	37·8 ± 0·43	·98 ± 0·31	34·9–40·7	37·0–39·0	2·6
PL	59·8 ± 1·14	2·56 ± 0·81	52·1–67·5	56·0–64·0	4·2
Sens.	63·0 ± 0·86	1·73 ± 0·61	57·8–68·2	60·0–64·0	2·7

Ratio of ASB/PSB = 40/29 and PW/SD = 1·335.

Dorsal setae ca. 52 in number and arranged ca. 2.12.8.10.8.6.4.2. Anterior median projection of scutum 18 μ long by 7 μ wide at base. The AM setae 11 μ apart at base and about 7 μ behind anterior scutal margin. Eyes 2 + 2. Legs rather longer than body, I 450 μ, II 370 μ, III 430 μ, including coxae; coxae I with two setae, II and III with one seta each, these setae tapering, finely ciliated and about 50 μ long; tarsi I and II with a stout dorsal sensory rod; all tarsi with paired claws and a rather longer slender, claw-like empodium; tibiae III with a pair of long slender whip-like setae, tarsi III with one such. Palpi and mandibles normal, chelae serrate. Gnathosoma with a pair of long ciliated setae. Between gnathosoma and coxae I on each side with a true stigmal opening as in *australiensis*. Ventrally, no setae between coxae I, a pair between coxae III and thereafter about 26 setae to 40 μ long.

Remarks—Three specimens from rats from Cairns, Queensland, 1939 (W. G. H.), agree with the above data except that PW, A-P and especially AL and Sens., are significantly greater. It hardly seems possible, however, to regard these specimens as more than a geographical variation.

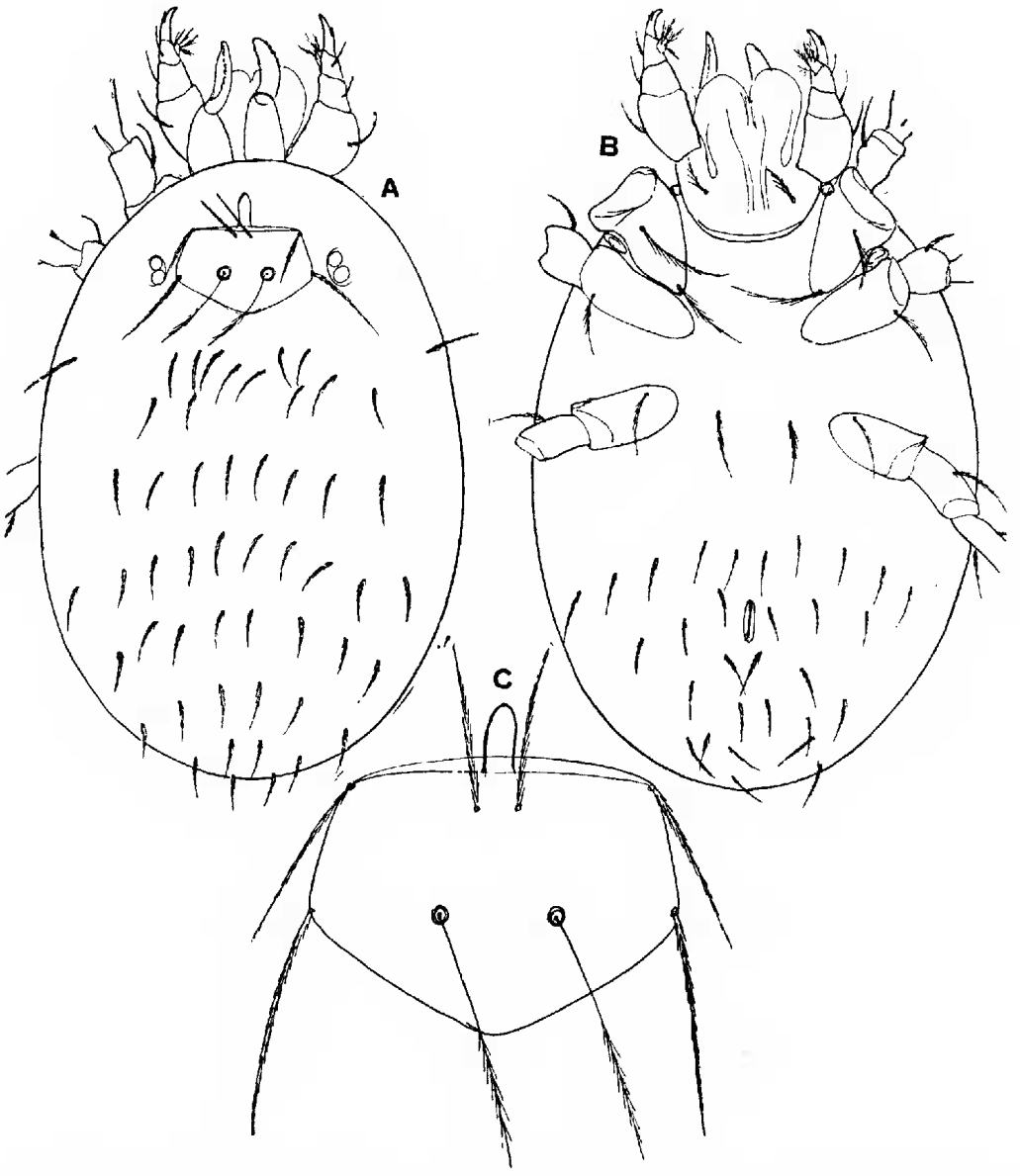


Fig. 10 *Leeuwenhoekia adelaideae* n. sp. Larva: A, dorsal; B, ventral; C, scutum x 500.

The Standard Data for these specimens are as follows:

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	74·0±1·05	1·82±0·74	68·5–79·5	72·0–75·0	2·5
PW	88·3±1·96	3·40±1·39	78·1–98·5	85·0–93·0	3·8
SB	29·0	No variation recorded			
SD	67·3±1·90	3·30±1·35	57·4–77·2	65·0–72·0	4·9
A–P	31·0±0·81	1·41±0·58	26·8–35·2	29·0–32·0	4·5
AM	43·3±1·65	2·87±1·17	34·7–51·9	40·0–47·0	6·6
AL	45·7±1·09	1·89±0·77	40·1–51·3	43·0–47·0	4·1
PL	58·0±1·49	2·58±1·05	50·3–65·7	54·0–60·0	4·45
Sens.	70·7±0·54	·94±0·38	67·9–73·5	70·0–72·0	1·33

Locality and *Hosts*—Five specimens from ears of domestic cats, three from Glen Osmond, South Australia, November 1931 (D. C. S.), and two from Unley, South Australia, February 1941 (R. V. S.). Also three specimens from rats, Cairns, Queensland, 1939 (W. G. H.).

Leeuwenhoekia hirsti n. sp.

Fig. 11, A–C

Description—Larva. Length (excluding gnathosoma) 330 μ, width 275 μ. Shape an elongate oval. Dorsal scutum as figured with the following Standard

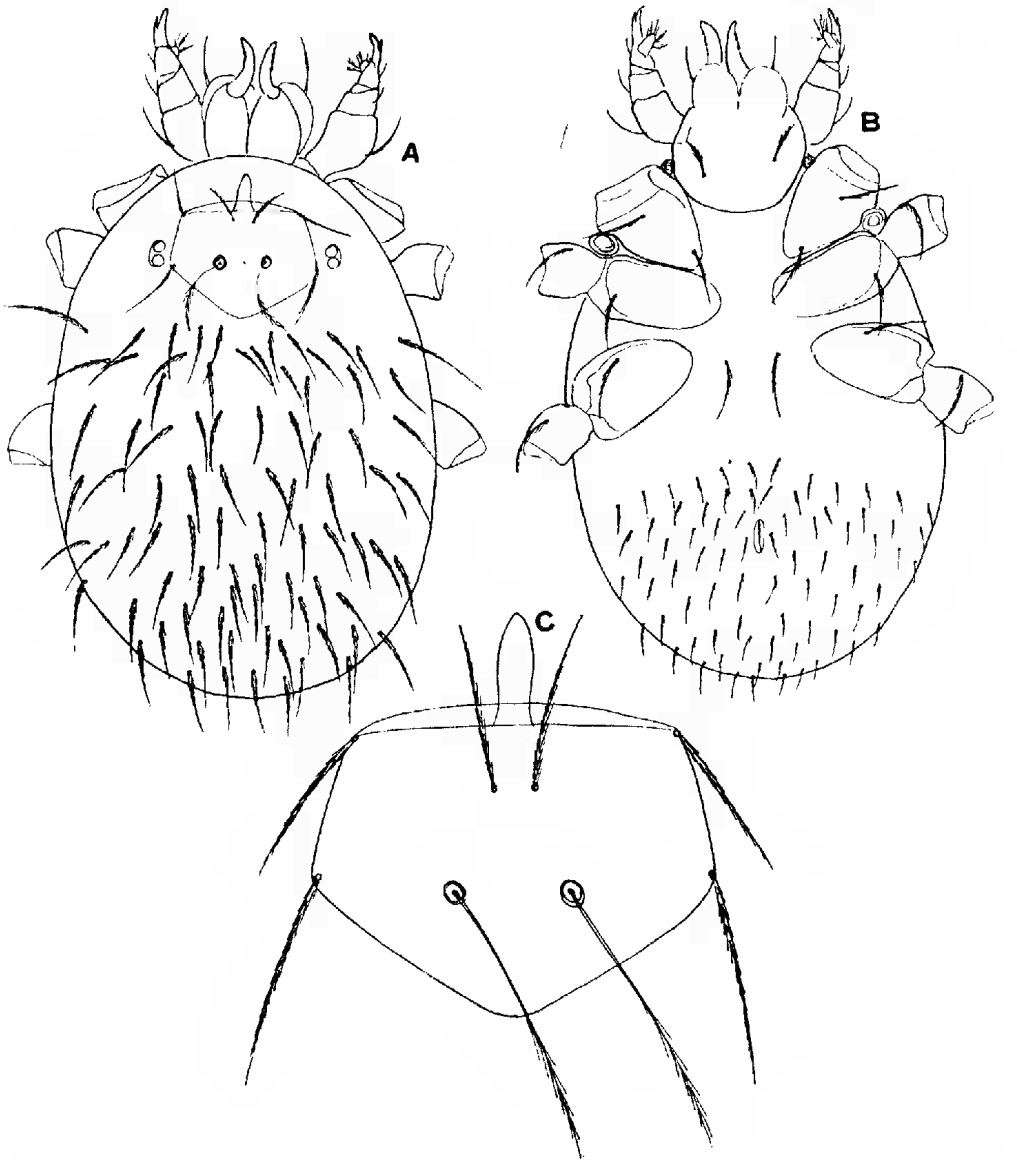


Fig. 11 *Leeuwenhoekia hirsti* n. sp. Larva: A, dorsal; B, ventral; C, scutum x 500.

Data in microns: AW 79, PW 97, SB 29, ASB 46, PSB 31·5, SD 77·5, A-P 36, AM 43, AL 43, PL 54, Sens. 72, DS 45-60, Ratio PW/SB = 1·252. Dorsal setae rather more robust than in *australiensis*, 82 in number and arranged ca. 2.8.12.10.10.12.8.8.6.4.2, the anterior rows rather confused. The AM setae 11 μ apart at base and about 21 μ behind anterior scutal margin. Anterior process of

scutum 29 μ long, and 11 μ wide at base. Eyes 2 + 2. Legs: I 360 μ, II 330 μ, III 375 μ, including coxae; coxae I with two setae, II and III with one seta, these setae to 40 μ long; tarsi I and II with dorsal rod-like seta; tibiae III with two long whip-like setae, tarsi III with one such; all tarsi with paired claws and rather longer, median claw-like empodium. A true stigma present on each side of gnathosoma. Palpi normal, with bifurcate tibial claw. Mandibles normal, chelae serrate. No setae between coxae I, a pair between coxae III, and thereafter 12.12.12.10.10.8.6.4.2 setae, to 36 μ long.

Locality—Described from a single specimen collected on boots at Skull Pocket, Kairi, Queensland, February 1943 (R. N. McC.).

Remarks—In the Standard Data this species agrees with *australiensis*, but differs in the greater number of DS (82) and in the somewhat deeper scutum, giving a PW/SD of 1·252. The DS are also more robust, and the ventral setae more numerous.

Leeuwenhoekia mccullochi n. sp.

Fig. 12, A–C

Description—Larvae. Length (excluding gnathosoma) to 315 μ, width to 210 μ. Shape an elongate oval. Dorsal scutum smaller and not as long as in other

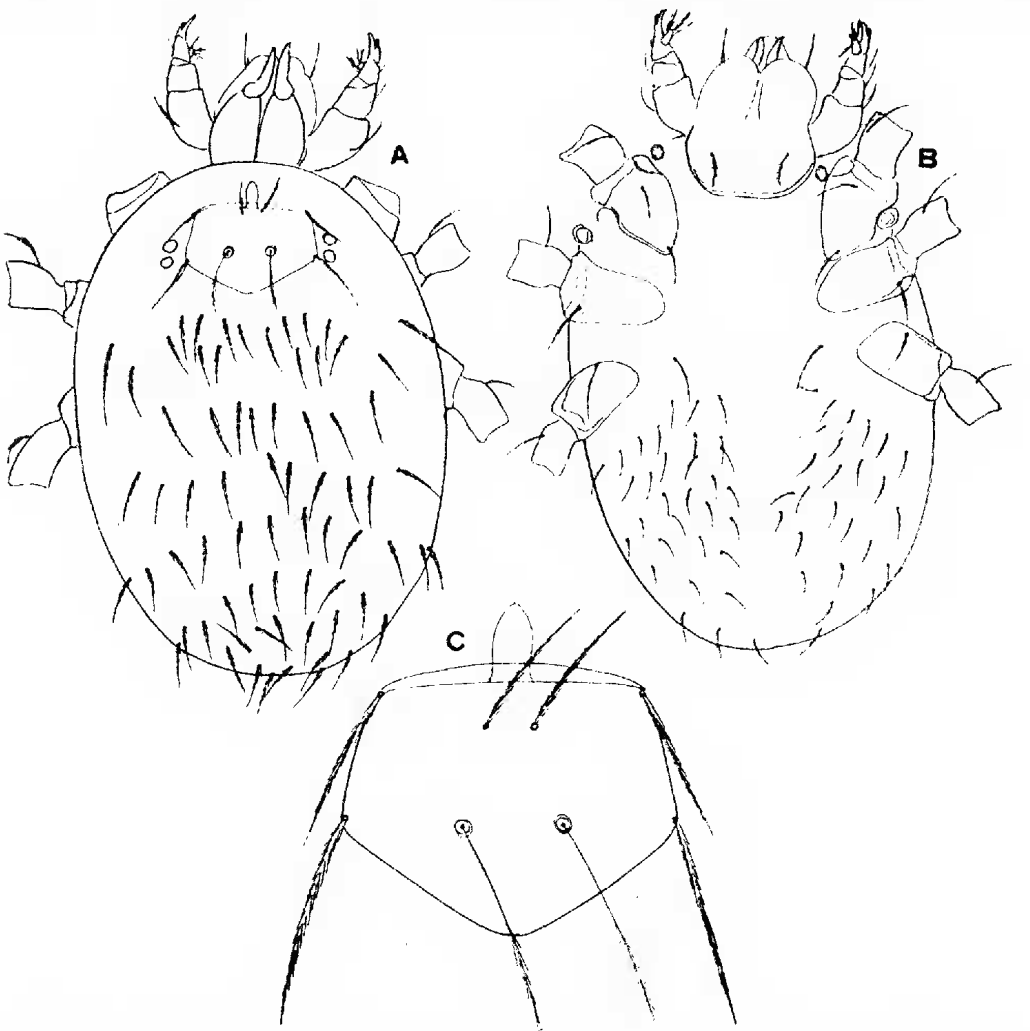


Fig. 12 *Leeuwenhoekia mccullochi* n. sp. Larva: A, dorsal; B, ventral; C, scutum 500.

species, as figured with the following Standard Data in microns, based on four specimens.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	64·0±0·87	1·73±0·61	58·8–69·2	61·0–65·0	2·7
PW	81·0±1·00	2·00±0·71	75·0–87·0	79·0–83·0	2·5
SB	25·0	No variation recorded			
SD	71·0±1·41	2·83±1·00	62·5–75·5	67·0–75·0	4·0
A–P	32·5±0·43	0·87±0·31	29·9–35·1	32·0–34·0	2·7
AM	36·5±0·43	0·87±0·31	33·9–39·1	36·0–38·0	2·4
AL	38·0±1·0	2·0±0·71	32·0–44·0	36·0–40·0	5·2
PL	54·0	No variation recorded			
Sens.	44·3±1·09	1·89±0·75	38·6–49·9	43·0–47·0	4·3

Ratio of ASB/PSB = 39/29 and of PW/SD = 1·194.

Dorsal setae ca. 70 in number 45-55 μ long, and arranged ca. 2.8.10.8.10.10.10. 6.4.2. Anterior median projection of scutum about 22 μ long and 10 μ wide at base. The AM setae 11 μ apart at base and about 15 μ behind anterior margin of scutum. Eyes 2 + 2. Legs: I 345 μ II 290 μ, III 360 μ; coxae I with two setae, II and III with one seta, these setae to 47 μ long, tarsi I and II with dorsal rod-like seta, all tarsi with paired claws and median claw-like empodium; tibiae III with a pair of long slender whip-like setae, tarsi III with one such. Gnathosoma with a pair of ciliated setae. A true stigma present on each side of gnathosoma. No setae between coxae I, a pair between coxae III, and thereafter 12.10.10.10. 6.4.2. setae, to 36 μ long and finer than the dorsal and other ventral setae. Palpi normal with bifurcate tibial claw. Mandibles with serrate chelicerae.

Locality—Four specimens collected on boots, on edge of scrub. Trinity Beach area, Queensland, July 1943 (R. N. McC.).

Remarks—Very distinct from all other species with approximately similar number of DS and whip-like setae on tibiae and tarsi III, in the Standard Data of the scutum.

Leeuwenhoekia southcotti n. sp.

Fig. 13, A–C

Description—Larvae. Length (excluding gnathosoma) to 310 μ, width to 260 μ. Shape elongate oval. Dorsal scutum small and relatively short, as figured, with the following Standard Data in microns based on seven specimens.

	Mean	Standard Deviation	Theoretical Range	Observed Range	Coeff. of Variation
AW	62·15±0·56	1·48±0·39	57·7–66·6	61·0–65·0	2·4
PW	82·4±0·66	1·76±0·46	77·1–87·7	79·0–85·0	2·1
SB	28·6±0·37	1·0±0·26	25·6–31·6	26·0–29·0	3·4
SD	49·1±0·51	1·35±0·36	45·1–53·1	47·0–50·0	2·7
A–P	27·6±0·49	1·29±0·34	23·7–31·5	26·0–29·0	4·6
AL	29·95±0·41	1·20±0·30	26·6–33·3	29·0–32·0	3·7
PL	40·85±0·51	1·35±0·36	36·8–44·9	40·0–43·0	3·3
Sens.	64·3±0·58	1·48±0·43	59·9–68·7	61·0–65·0	2·3

Ratio of ASB/PSB = 24/19 and of PW/SD = 1·744.

Dorsal setae ca. 42, arranged ca. 2.6.6.8.8.6.4.2. strong, ciliated and apically blunt. Anterior median projection of scutum 14 μ long by 5 μ wide at base. The AM setae with bases 5 μ apart and about 4 μ behind anterior margin of scutum. Eyes 2 + 2. Legs: I 340 μ, II 305 μ, III 390 μ, including coxae; coxae I with two setae, II and III with one seta, 32 μ long; tarsi I and II with usual dorsal rod-like seta, III without any whip-like setae on tibiae or tarsi; all tarsi with paired claws and longer claw-like empodium. Gnathosoma with a pair of ciliated setae.

On each side of gnathosoma and between coxae I is a true stigma as in *australiensis*. No setae between coxae I, a pair between coxae III, and thereafter 8.4.4.4.4.4.4 setae.. Palpi normal with bifurcate tibial claw. Mandibles with chelae serrated.

Locality and *Hosts*—Two specimens from a skink (*Lygosoma* sp.) from Adelaide River, Northern Territory, Australia, June 1943 (R. V. S. Slide ACB 169B) and eight specimens from a similar host and the same locality July 1943 (R.V.S. Slide ASB 169A).

Remarks—Differs markedly from all other species in the Standard Data and the lack of the long whip-like setae on tibiae and tarsi III.

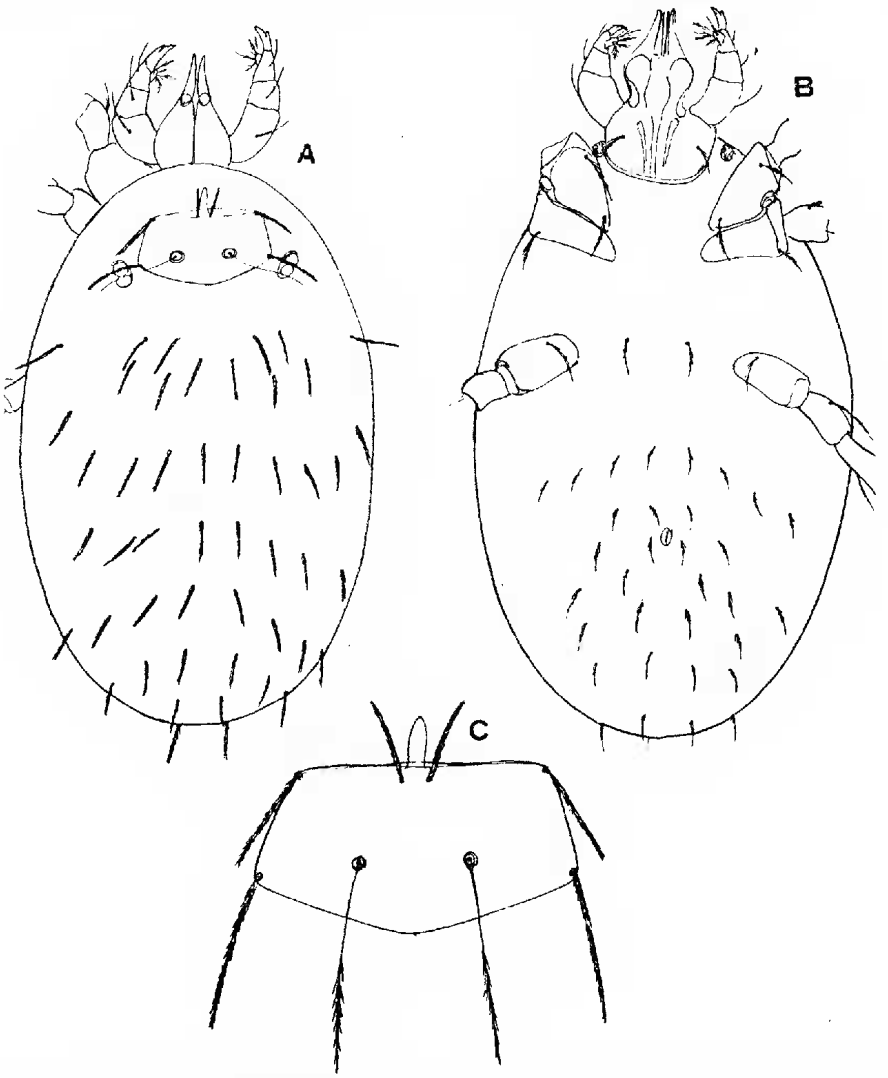


Fig. 13 *Leeuwenhoekia southcotti* n. sp. Larva: A, dorsal; B, ventral, C, scutum x 500.

Leeuwenhoekia nova-guinea n. sp.
Fig. 14, A–C

Description—Larvae. Length, fully fed to 800 μ, unfed 400 μ, width fully fed to 600 μ, unfed 320 μ. Shape an elongate oval, in life and before mounting with a distinct contraction behind coxae III. Dorsal scutum as figured, with the sides of the posterior angle slightly concave, and with the following Standard Data in microns based on 12 specimens.

	Mean	Deviation Standard	Range Theoretical	Range Observed	Variation Coeff. of
AW - -	85·75 ± 1·35	4·69 ± 0·96	71·7–99·8	79·0–93·0	5·4
PW - -	98·4 ± 1·18	4·09 ± 0·83	86·1–110·7	94·0–108·0	4·1
SB - -	27·9 ± 0·65	2·27 ± 0·46	21·1–34·7	25·0–32·0	8·1
SD - -	73·0 ± 1·84	5·21 ± 1·30	57·4–88·6	65·0–79·0	7·1
A–P - -	34·25 ± 1·23	3·48 ± 0·87	23·85–44·65	29·0–38·0	10·1
AM - -	41·5 ± 0·94	2·97 ± 0·66	32·6–50·4	36·0–45·0	7·1
AL - -	62·1 ± 1·68	5·84 ± 1·19	44·6–77·6	54·0–72·0	9·4
PL - -	72·8 ± 0·74	2·58 ± 0·52	65·1–80·5	70·0–79·0	3·5
Sens. - -	58·7 ± 1·33	4·22 ± 0·94	46·1–71·3	54·0–65·0	7·2

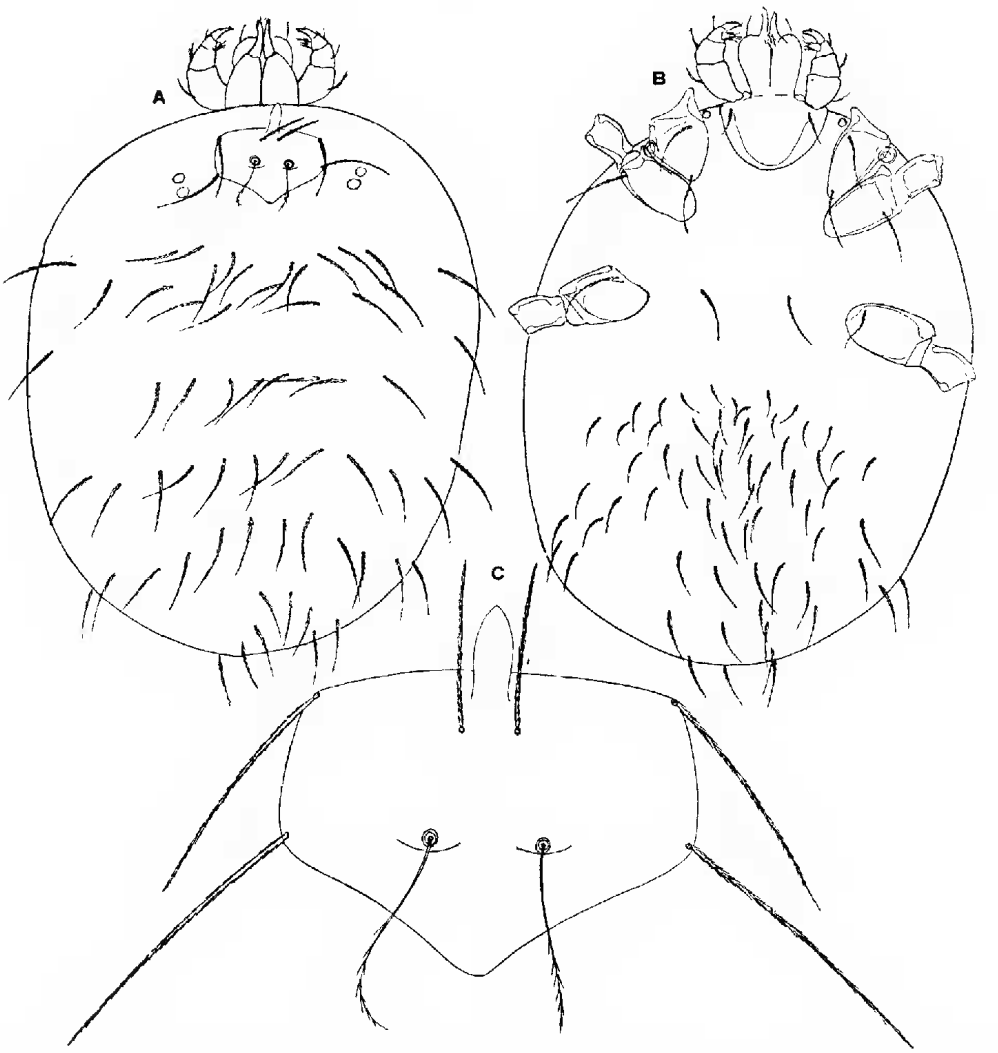


Fig. 14 *Leeuwenhoekia nova-guinea* n. sp. Larva: A, dorsal; B, ventral; C scutum x 500.

Ratio setae ca. 62 and arranged ca. 2.12.8.10.12.10.6.2, but the transverse rows are difficult to interpret, fairly strong and strongly ciliated. Anterior process of scutum 25 μ long by 11 μ wide at the base. The AM setae with their bases 14 μ apart and placed 14 μ behind the anterior margin of scutum. Eyes 2 + 2. Legs: I 480 μ long including coxae, II 430 μ, III 490 μ; coxae I with two slender,

60 μ, fine setae, II and III with one seta; no pair of setae between coxae I, a pair between coxae III and thereafter about 70 setae 30-45 μ long; tarsi with paired claws and slender claw-like empodium; tarsi I and II with short dorsal rod-like seta; tibiae III with a pair of long simple whip-like setae and tarsi III with one such. Palpi normal with bifurcate tibial claw. Mandibles with serrate chelae. Gnathosoma with a pair of ciliated setae. Between base of gnathosoma and coxae I, on each side is the characteristic true stigma of the subfamily.

Locality and *Hosts*—A number of specimens from a magpie, *Gymnorhina* sp. Buna area, New Guinea, 21 November 1943 (G. M. Kohls), and from a kingfisher, same locality, 27 November 1943 (G. M. K.).

Remarks—Differs from other species in the number of DS, the Standard Data and the form of the dorsal scutum, as well as the construction behind the third pair of coxae.

KEY TO THE AUSTRALIAN AND NEW GUINEA SPECIES OF LEEUWENHOEKIA

1 Tibia and tarsi of leg III with some long simple whip-like setae. 2
No long whip-like setae on tibiae or tarsi of leg III. Scutum small and relatively shallow, PW/SD = 1·74. AW 62·15 ± 4·45, PW 82·4 ± 5·3, SB 28·6 ± 3·0, SD 49·1 ± 4·0, A-P 27·6 ± 3·9, AM 20·9 ± 1·1, AL 29·9 ± 3·3, PL 40·8 ± 4·0, Sens. 64·3 ± 4·4. DS relatively short, straight and blunt at apex, 42 in number. *L. southcotti* n. sp.

2 PW/SD less than 1·3. 3
PW/SD greater than 1·3. 4

3 PW/SD = 1·194, DS ca. 70 in number. AW 64·0 ± 5·2, PW 81·0 ± 6·0, SB 25·0, SD 71·0 ± 8·5, A-P 32·5 ± 2·6. AM 36·5 ± 2·6, PL 54·0, Sens. 44·3 ± 5·7. DS tapering 45-55 μ long. *L. mccullochi* n. sp.
PW/SD = 1·252. DS ca. 82 in number AW 79·0, PW 97·0, SB 29·0, SD 77·5, A-P 36·0, AM 43·0, AL 43·0, PL 54·0, Sens. 72·0. DS tapering. *L. hirsti* n. sp.

4 DS 52-54 in number. PW/SD = 1·336. AW 76·4 ± 5·9, PW 92·4 ± 3·6, SB 28·8 ± 4·4, SD 69·2 ± 1·2, A-P 32·8 ± 1·2, AM 41·2 ± 4·4, AL 37·8 ± 2·9, PL 59·8 ± 7·7, Sens. 63·0 ± 5·2. *L. adelaideae* n. sp.
DS 62 in number. PW/SD = 1·32. AW 85·7 ± 14·0, PW 98·4 ± 12·3, SB 27·9 ± 6·8, SD 73·0 ± 15·6, A-P 34·2 ± 10·4, AM 41·5 ± 8·9, AL 62·1 ± 17·5, PL 72·8 ± 7·7, Sens. 58·7 ± 12·6. *L. nova-guinea* n. sp.
DS 76 in number. PW/SD = 1·32. AW 77·3 ± 14·2, PW 93·4 ± 14·3, SB 30·2 ± 6·1, SD 70·8 ± 10·5, A-P 31·9 ± 5·3, AM 44·9 ± 9·8, AL 49·0 ± 9·6, PL 63·6 ± 8·2, Sens. 64·0 ± 8·3. *L. australiensis* Hirst

N.B.—The values of the Standard Data given in this key are the Means plus or minus three times the Standard Deviation, *i.e.*, they indicate the theoretical range of variation.